JOURNAL OF THE

SMPTE

1 Monochrome Television Film Standards • *K. B. Benson and J. R. Whittaker*

6 Laboratory Practices on Films for Television • *Recommended by the Association of Cinema Laboratories*

8 The Optics of the Lenticular Color-Film Process • *Rudolf Kingslake*

13 Devices for Making Sensitometric Exposures on Embossed Kinescope Recording Film • *Edward M. Crane and C. H. Evans*

17 An Instantaneous Electronic Color-Film Analyzer • *B. D. Loughlin, C. E. Page, Wm. F. Bailey, C. J. Hirsch, A. J. Miller and Leonard Giarraputo*

27 An Electromechanical Light Valve for Motion-Picture Printers • *Frank P. Herrnfeld*

29 Glass Filters for Color Printing • *R. L. White and R. C. Lovick*

32 Recording Lip-Synchronized Sound Using a 16mm Magnetic-Optical Sound Projector • *Lee T. Askren and Raymond J. Dwyer*

35 Ultra-Cold Weather Photography • *Richard R. Conger*

83d SMPTE Convention • April 21–26 • Ambassador Hotel, Los Angeles

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Monochrome Television Film Standards

By K. B. BENSON and J. R. WHITTAKER

The television system requirements and audience environment conditions differ materially from those common to motion-picture theater practice. It is necessary that the standards followed for the production and processing of films for television take into account these differences. In addition, the increased complexity of the combined motion-picture and television system over the direct projection system limits the degree of freedom permissible in many phases of the operation. The standards for optimum results with the combined motion-picture and television system are developed by an examination and correlation of the relationships between the two component processes and their effects upon the end product.

THE PRODUCTION AND PRESENTATION of a television program on film, whether it is a ninety-minute extravaganza or a ten-second spot announcement, is an exceedingly complex operation. In live television, program production and transmission are controlled by the broadcaster and occur simultaneously. By contrast, a film program operation may extend over a period of days or even months, and involve the services and facilities of at least three relatively independent organizations. Such decentralization often results in confusion concerning the extent of areas of responsibility and brings about a lack of understanding among the various groups regarding each other's problems. Furthermore, the delay before the end product can be evaluated prohibits the use of the live television techniques that permit correction of technical faults as they occur. Instead, to save re-shooting film, correction of one error often is attempted by the introduction of another, partially compensating, error. As the broadcaster knows only too well, this chore often is relegated to the television control room because of a widely-held opinion that the film show, by means of some electronic magic, can be made equal or superior in quality to live television.

Television film quality comparable to live programming can be achieved only by the maintenance of careful control over every phase of the overall process from film production through broadcast transmission. The standards of control must be determined by consideration not only of their relation to each intermediate product, but in particular, the effect upon the end product, the television picture and sound presentation on the *home receiver*. It must be emphasized that the end product is not the projection of the film in a theater or the television presentation in the studio control room, but that it is the product delivered to the home audience.

Therefore, the first step is to define and comprehend the requirements of the television receiver; then the characteristics of the operations before the picture reaches the receiver may be examined independently to determine the effect of variations in control upon the picture and sound quality of the end product.

Presented on October 5, 1957, at the Society's Convention at Philadelphia by K. B. Benson and J. R. Whittaker (who read the paper), CBS Television, 485 Madison Ave., New York 22.
(This paper was received on October 22, 1957.)

Areas of Responsibility

The motion-picture television-transmission system is divided into three major areas of responsibility: production, processing, and reproduction. The activities falling into each of these categories are listed in Table I. Under the heading of "production" are included lighting, choice of settings and costumes, camera operation and exposure, choice of film stock, and sound pickup and recording.

After exposure of the picture and sound negatives (or magnetic taping of sound), the responsibility passes on to the processing operation. This phase of activity covers optical effects, the development of picture and sound negatives, and the printing and development of the composite positive print. The processing takes place in an establishment which has been given the unfortunate name of "laboratory," a title implying that experimentation is the prime activity. It is extremely important that an experimental type of operation be avoided at all times and instead, the processing be in accordance with strict specifications.

The laboratory delivers a composite picture and sound print to the television broadcaster who then has the responsibility to transmit a television signal which will reproduce the information on the film, faithfully upon a properly adjusted home receiver. If prior operations

TABLE I: MOTION PICTURE TO TELEVISION AREAS OF RESPONSIBILITY

Top-quality television film reproduction can be achieved consistently only when competent film and television organizations function in their specific areas without interdependence or overlap of responsibilities.

PRODUCTION	PROCESSING	REPRODUCTION
Lighting	Development	Projection
Settings	Printing	Camera Control
Costumes	Editing	Sound Pickup
Exposure	Opticals	Transmission
Film Stock		Reception
Camera Operation		
Sound		

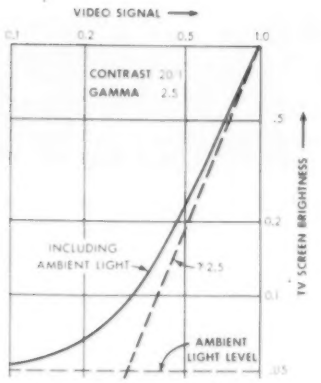


Fig. 1. The high ambient light level common for television viewing causes the picture-tube transfer characteristic to depart from a uniform power law and, as a result, limits the available brightness range.

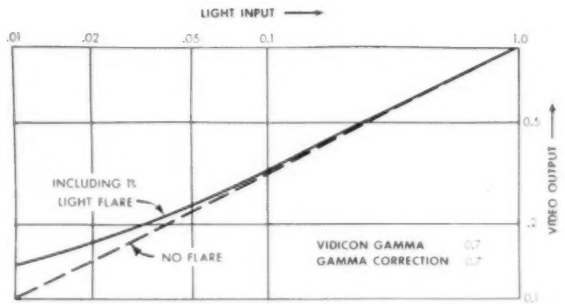


Fig. 2. Light scattering or flare in the pickup tube and camera lens causes the camera-chain transfer characteristic to depart from a straight power law.

have been conducted correctly, it should be possible to perform this function with a minimum of adjustment of the electronic equipment. Unfortunately, the last link in this final phase, the home television receiver, is one over which our industry can exert little control. Compromises have to be made for variations that may exist in the receiver and the accompanying viewing conditions.

Each of the three major operations, production, processing and reproduction, must be performed without an interdependence or overlap of responsibilities. For example, an attempt to correct a lighting error of the production phase by nonstandard procedures in the processing phase will produce only a minor correction in the end product. More often than not, some other more objectionable degradations will be introduced.

Television System Requirements

The controls over film production and processing operations needed to produce good quality theater reproduction are fairly well established. The differences required for television film can be determined only by an examination of the requirements of the television process and their relationship to motion-picture characteristics.

There are two characteristics of present-day commercial television picture transmission techniques which are of major importance. First, contrary to motion-picture practice, television viewing most frequently takes place under conditions of relatively high ambient lighting. Thus, even though the highlight brightness of the television screen may be four or five times that of a motion-picture screen, the contrast range may be only a fourth. The net result may be a contrast range of 20 to 1 for television compared to 80 to 1 for good quality theater projection. Second, the contrast range which can be accepted by the television pickup tube is restricted by the electronic noise level. The figure for a vidicon with a good, low-noise preamplifier, and appropriate aperture and gamma correction is in the order of 30 to 1 (in terms of the diffuse density* range of motion-picture film).

The effect of ambient light upon a television receiver display is shown in Fig. 1.† The $2\frac{1}{2}$ power transfer characteristic of a picture tube (the straight dashed line) is modified so as to approach the ambient light level asymptotically. In other words, the high ambient level introduces a large degree of black compression.

A similar effect takes place, but to a lesser degree, in the film camera pickup tube. A vidicon camera chain with appropriate gamma correction will have a $\frac{1}{2}$ power transfer characteristic. This is shown as the dashed line in Fig. 2. However, flare or scattering of light in the TV camera lens and in the vidicon tube itself, is at least 1%. Thus, a departure from the straight power law curve (dashed line) in the direction of black compression results. In the other popular film pickup tube, the iconoscope, this effect may be appreciably greater, and will vary with average scene brightness because of the large amount of electron redistribution.

Motion-Picture System Characteristics

A typical overall negative-positive transfer characteristic compiled from data taken at several major New York film laboratories is shown in Fig. 3. The film stocks employed were standard negative and release print positive. The processing control gammas were 0.66 for the negative and 2.5 for the positive. As in the case of the television components, in order to integrate the film characteristic into the overall system the curve has been modified for the flare of the film camera lens and of the projector lens.‡ The total flare factor of 1% has the effect of introducing a small degree of black compression.

The peak exposure (represented by unity on the curve) corresponds to a print density of 0.2. Points on the solid, corrected curve corresponding to any other specific densities are determined by an intersection of a horizontal projection from the appropriate point on the dashed curve. As is shown in subsequent paragraphs, for optimum performance the range of permissible film densities is defined rather precisely. Specifically, it is recommended that the negative and positive exposures be controlled in a manner which results in positive print densities of not less than 0.4 or more than 1.9. Further, the negative exposure should be such as to utilize the straight portion of the film's H&D characteristic.

The Combined Film and TV System

The components of the complete system, that is, the film, the TV pickup tube and the TV picture tube, may be combined graphically[1] to determine the relationship between the negative exposure and the television reproduction (Fig. 4).

The lower right quadrant in Fig. 4 shows the film curve of Fig. 3 redrawn (curve 1) with the maximum scene brightness corresponding to a recommended minimum print density of 0.4. The minimum scene brightness to be reproduced is represented by a maximum

* The specular density characteristic (which results from the limited angle of light collection of the camera and projector lens systems) extends the black end of the transfer characteristic to produce an effective contrast range in the order of 60 to 1. However, for all practical purposes, the effect upon the video signal of this increase in contrast, is nullified by the incomplete, low-light gamma correction provided in the majority of commercially available vidicon camera chains.

† The coordinates for this and subsequent graphs of the component and system transfer characteristics have been normalized. That is, the peak values of brightness or video signal voltage (as the case may be) are represented by a value of unity. Thus, the curves describe the general case. Application to a specific case can be accomplished by a simple multiplication of the data by the appropriate normalized coordinates.

‡ A similar flare factor is included in the television camera chain characteristic to account for its lens and projector multiplexer system.

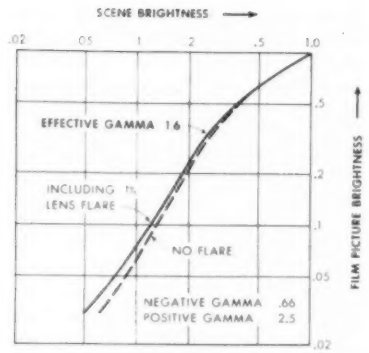


Fig. 3. The negative-positive film transfer characteristic determined from laboratory data (dashed curve) is modified by the flare in the camera and projector lenses (1/2% each) in order to obtain the motion-picture system characteristic.

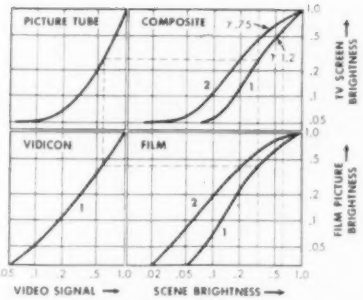


Fig. 4. The relationship between scene and television screen brightness, shown in the upper right quadrant, is obtained by a graphical combination of the system component characteristics. The dashed rectangle indicates, for one point on curve 1, the transfer process employed in combining the three curves. The dashed vertical lines are the recommended limits on curve 1 for placement of skin tones. Curve 1 with a minimum positive print density of 0.4 gives a desirable gamma of 1.2 in the region of skin tones. A reduction to a minimum density of 0.2 (curve 2) results in compressed highlights, as shown by a gamma of 0.75.

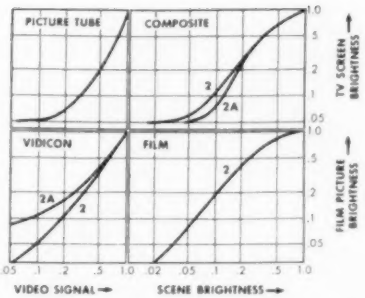


Fig. 5. Curve 2A shows the effect of an attempt to correct for the compressed and overly bright highlights of curve 2, Fig. 4, by means of camera-chain readjustment. The result is the addition of another degradation, compressed low lights.

print density of 1.9. It should be noted that this is equivalent to a contrast range of 30 to 1, the recommended limit for television applications. The dashed vertical lines indicate the recommended limits for placement of skin tones in a normally lit scene.

In the lower left quadrant the TV camera-chain transfer characteristic of Fig. 2 is redrawn in a manner which places the peak output signal at a level corresponding to the maximum light transmission of the film curve. The video amplitude (camera-chain gain adjustment) and black level of the camera-chain curve have been adjusted so that the setup level or minimum video output level corresponds to the minimum transmission of the film. In the upper left quadrant the picture tube characteristic of Fig. 1 with the ambient light correction has been drawn with the peak brightness and black levels located at corresponding output levels of the pick-up tube.

No correction has been made in the film curve for the difference between the diffuse density figures and the specular density characteristic which results from the restricted angle of light collection of the projection lens. This complication has been omitted because the black stretch this effect produces is very nearly cancelled by the incomplete low-light gamma correction incorporated in most commercially available camera chains.

The overall transfer characteristic of scene brightness relative to picture tube brightness can be derived by transferring the points on the film curve through the other two curves to intersect the corresponding exposure ordinates in the upper right quadrant. This resultant curve in the upper right quadrant of Fig. 4 is a fairly straight line with only a slight amount of compression in the extreme blacks and in the extreme highlights. Most important of all, the portion where skin tones will occur from a properly lighted scene has a very nearly linear slope with a gamma of 1.2.

The lower limit for the intensity of low lights (or the maximum print density) is determined by the projector and camera-chain pick-up tube characteristics. The desirable limit for peak highlights can be determined by an investigation into the effect of decreasing the print density below the figure of 0.4 employed for curve 1 of Fig. 4. The film characteristic, shown as curve 2 in the lower right quadrant of Fig. 4 has been drawn with the peak highlight corresponding to a print density of 0.2. In this case the light level into the vidicon then would be readjusted to produce the same peak video level. It can be seen that a somewhat greater range of scene brightness is covered. However, as indicated on the composite characteristic curve 2 in the upper right quadrant, the skin tones are increased in brightness and compressed (0.75 vs. 1.2 gamma). Under conditions such as these, the video operator normally would reduce blanking to pull down the overly bright faces. The resulting change in the composite characteristic is shown in Fig. 5. The vidicon curve 2 has been redrawn as 2A (lower left quadrant) to take into account the camera-chain readjustment. The effect of these readjustments upon the composite curve is shown as curve 2A in the upper right quadrant. The only change between curve 2 (before blanking adjustment) and 2A (after adjustment) is a material increase in black compression. The skin tones still are compressed with the curve slope remaining at an average gamma of 0.75. Thus, it is seen that readjustment of the film camera chain cannot compensate for film prints of incorrect density.

Lighting Requirements

It is apparent that for optimum performance of the television system the permissible range of densities is rather precisely defined. In order to keep within these limits, staging techniques somewhat different from normal motion-picture practice must be employed. Thorough coverage of this subject is beyond the scope of this paper but the more significant characteristics are outlined below. An earlier paper contained a detailed discussion of the subject.[2]

The ratio of key light to effects light must be reduced. Ratios of as much as 10 to 1 can be employed successfully for films intended for theater projection. However, for television no more than 3 to 1 can be tolerated. This lower ratio should not be obtained by sacrificing the very essential effects lighting. In fact, because of the limited brightness range and small size of the resultant television picture, departures from extreme flat lighting are all the more desirable to provide a feeling of depth and sharpness.

In addition to the careful use of effects light, the type of light source can have appreciable bearing upon the apparent sharpness of the television picture. This is indicated in Figs. 6 and 7. The only difference between these two pictures is the change from diffuse (Fig. 6) to specular light (Fig. 7). The shadows cast by the specular light source provide an increased contrast to any edges or textured surface. This creates the effect of increased sharpness.

Placement of Skin Tones

So far we have set the boundary conditions for the film product and very broadly indicated the lighting problems. Of equal importance is the placement of portions of the picture within this range. In a normal or high-key scene, where the



Fig. 6. The use of only diffuse lighting of the subject in the above photograph resulted in a lack of detail and apparent resolution.

extreme shadows or black areas represent only a small portion of the total picture area, the flesh tones should be in the range of print density of 0.5 to 0.8. The density of the large areas should differ somewhat from the skin tones in order to give contrast. This difference should be held down to a value of no more than 0.3 or 0.4. This would seem too elementary to stress, were there not continually submitted for broadcast a large number of films in which skin tones are grossly misplaced. Variations encountered in film received for a normal broadcasting operation have been found with densities ranging from 0.2 to 1.3.

High-Key vs. Low-Key

The counterpart of the high-key scene is the low-key, one in which the major portion of the picture area reproduces as black or near-black. In this case the flesh tones for best results should have a density of between 0.8 and 1.40. Because of the compressed low-light scale, resulting for the most part from the high ambient light level conditions of viewing, the low-key scene is very difficult to reproduce over television. Care should be taken to avoid excessive fine detail or minute tonal scale separations.

There is one other serious drawback to the use of extreme low-key in television films, or for that matter, in live television. This comes about because the majority of the television receivers in use, unlike control room monitors, do not have circuitry for maintaining black level at a specific point. Consequently, the black level will shift in accordance with the average scene brightness. The effect on a low-key scene is to reproduce the supposedly black areas as a milky gray. This disturbing effect can be alleviated without destroying the low-key effect by breaking up the solid black background. The use of a textured backdrop is one very successful approach.



Fig. 7. Except for a change from diffuse to specular lighting, the conditions for the above photograph were the same as for Fig. 6. The shadows cast by the light source produce an increase in detail and apparent resolution.

Audio Requirements

All too often the glamour and sheer novelty of the picture operation cause an unequitable division of emphasis between the sound and picture problems. This is unfortunate because the recording and processing of the audio portion of a show leave little leeway for departure from prescribed limits. Recording film for variable-area soundtracks should be processed to a minimum control gamma of 3.0. The variable-density recording stock, on the other hand, should be held within the range of 0.4 to 0.6. The exact value of negative density should be determined by tests for minimum cross-modulation in the case of variable area, and intermodulation for variable density. Only by day-to-day adherence to these optimum values of density, at the stated gamma, can good quality sound be obtained. It is also important that standard processing of the positive print be followed. Any deviations here in an attempt to correct for shortcomings in the picture will, of course, have a serious effect on the audio-track.

Not to be forgotten in the overall production is the fact that the television film is reproduced in the intimate surroundings of the private home, not a large theater. The large dynamic range so effective in the theater cannot be handled properly at the lower volume levels common on home receivers. Just as the picture is usually reproduced at a reduced brightness range, the audio is reproduced at a reduced amplitude range. Another difference from theater reproduction is that the televiewer frequently hears live and film audio interspersed. Many soundtracks which may be acceptable when not subjected to this

direct comparison are completely unsatisfactory when integrated with a live pickup.

Picture Area Reproduced

Another requirement of the television system, which is difficult to define, involves the cutoff of picture area which occurs on the home receiver. The broadcaster transmits the area specified in American Standards PH22.95 and PH-22.96. This reduces the height and width of the projector aperture by approximately 3%. The precise numerical values for the camera, projector and television apertures for 35mm and 16mm film are given in Table II. The picture area which appears on the home screen may vary widely, depending upon the service adjustments, the conditions of the set, or upon the level of the a-c line voltage. Because of these many variables, most receivers are designed to overscan the full picture-tube mask under the most adverse set of conditions since, if a receiver is underscanned, the viewer will usually complain of the black areas between the picture and the mask. On the other hand, any moderate amount of overscanning is not noticed by the viewer. To insure that essential material in the picture is not lost to the home viewer, it is advisable to keep this information inside a barrel-shaped rectangle whose horizontal and vertical dimensions are 80% of the scanned picture area (Fig. 8). In the production of animated material the rectangle can be specified as that encompassed by a seven-field in an eleven-field picture area.

Table II. Motion-Picture Apertures.

	35mm		16mm	
	Height	Width	Height	Width
Camera Aperture	0.631 in.	0.868 in.	0.292 in.	0.402 in.
Projector Aperture	0.612 in.	0.816 in.	0.285 in.	0.380 in.
Television Scan	0.594 in.	0.792 in.	0.276 in.	0.368 in.
Television Reduction of Projector Aperture	2.9%	2.9%	2.8%	3%

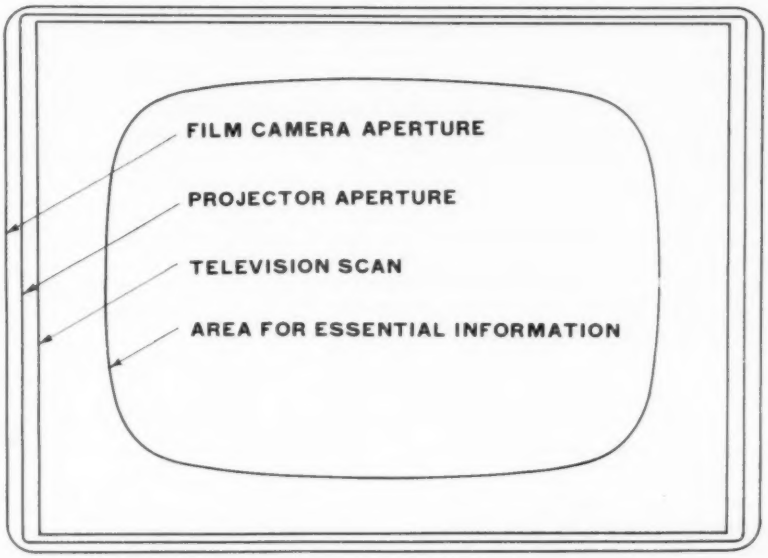


Fig. 8. Variations in the home receiver design, adjustment and operating conditions normally result in an appreciable reduction in the reproduced picture area. Therefore, it is advisable that essential picture material be kept within a barrel-shaped rectangle similar to that shown above.

Conclusion

To achieve top-quality reproduction of a television film program, it is essential that all phases of the operation be carefully controlled in a manner which takes into account the requirements of the television system. Evaluation of the quality should be based on the end product, that is, the picture and sound produced on the home television receiver, not on the results at some intermediate step. Because of the reduced contrast of the television screen compared with the motion-picture screen, and because of the limited brightness range accommodated by the TV pickup tube, a contrast of no more than 30 to 1 should be provided in the positive print. The requirements of present-day television film systems are such that the maximum print density should not exceed 1.9. With this density range a pleasing tonal rendition is obtained with the negative processed to a gamma of 0.6 to 0.7 and the positive to 2.3 to 2.6. Production techniques must be modified to result in these positive print contrast ranges, if best reproduction is to be obtained on the TV home receiver.

Above all, each of the separate operations, viz., production, processing, and reproduction, must be performed without interdependence or overlap of responsibilities. Any attempt to correct shortcomings of one step by introducing nonstandard techniques at some other step can produce only a relatively minor change in the end result, and more frequently will introduce other more objectionable detrimental effects. Broadly speaking, the proper balance between artistic considerations and technical quality must be achieved in the production phase. The film laboratory must work toward a strict formula operation; the television broadcaster must function with a minimum of operational adjustment to accomplish a consistent, reliable transmission. Only under these conditions can a high level of quality possible from a television film production be obtained.

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Laboratory Practices on Films for Television

Recommended by THE ASSOCIATION OF CINEMA LABORATORIES

A contribution to the *Journal* first submitted on October 9, 1957, and in its present form on November 27, 1957, by Reid H. Ray, President of the Association of Cinema Laboratories. Since the first printing in October 1957, the Association has made reprintings because of the great interest in the subject. The ACL Recommendations are published here for the information of the membership, to foster discussion and industry understanding through the columns of the *Journal*, Engineering Committee activities, conventions and meetings. Reprints of this document are available only from ACL sources; address: The Association of Cinema Laboratories, Inc., 1905 Fairview Ave., N.E., Washington, D.C.

These recommended laboratory practices on films for television are intended as a guide for both producers and laboratories engaged in production and processing of such films. The recommendations contained herein are based on a committee survey of the literature and answers to a questionnaire sent to numerous people engaged in production, laboratory and television operations.

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BLACK-AND-WHITE

Photography and Lighting for Optimum Quality

Any recommendations for laboratory practices on films for TV should include certain recommendations for photography, lighting and production. The laboratory can achieve the best results with the aid and cooperation of the people in these fields.

(1) Negative (or reversal original) should neither be underexposed nor overexposed, as set forth in film manufacturers recommendations. This is particularly important when the faces or essential shadow detail are unavoidably at extremes of the brightness range.

(2) The use of close-ups and medium camera shots with only infrequent use of long shots is recommended. Wide-angle shots and long shots should be used only to establish the perspective.

(3) The ratio of key to fill lighting should be kept within the range of 1½ to 1 and 2½ to 1. The maximum brightness contrast in the scene, as read by reflectance meters, should preferably not be greater than 20 to 1, but in any case should not be greater than 30 to 1. Uniformity of fill lighting throughout the scene is advisable.

(4) Night effects should be achieved by proper use of lighting and set inferences, instead of requiring the printing down of day scenes for night effect, which is sometimes done for theatrical use.

(5) Large areas of either white or black in the picture should be avoided wherever possible. Large areas of any uniform density are not advisable.

(6) Backgrounds for titles, trademarks and inserts should not utilize large expanses of uniform, unbroken density, especially if the background is very light or very dark.

(7) Cutting back and forth between scenes where the background is alternately dark and light should be avoided. Alternate camera angles in a given sequence should have similar background brightness.

(8) Scenes should be composed and lighted so that there is always something in the scene lighter than the face, or point of interest, and, if possible, something darker than the face.

(9) Camera apertures should cover sufficient frame area to be as large or larger than the television transmitted area. All important action should take place within the "safe action area." All titles and other written material should be kept well within the "safe title area." These areas are as follows:

Areas	*Width × Height, Inches*
35mm Transmitted:	0.792 × 0.594
Safe Action:	0.712 × 0.478
Safe Title:	0.621 × 0.466
16mm Transmitted:	0.368 × 0.276
Safe Action:	0.331 × 0.248
Safe Title:	0.288 × 0.216

The recommended review room projector aperture size is 0.746 in. wide by 0.531 in. high, with rounded corners.

The safe action area and safe title area are those areas which will be seen on the majority of home TV receivers. Titles or important action should not extend into the corner areas as these areas may be lost due to the oval shape of some receiver masks.

Laboratory Practices

Original Negatives should be developed to a normal Ib gamma of 0.65 to 0.70. The IIb gammas for a given Ib gamma will vary with film stocks and developers. Negatives should be free of excessive abrasion, dirt, drying streaks and water spots, within the laboratory control. Negatives should be developed with sufficient agitation so that directional effects are minimized.

Master Positives (Fine Grains) should be developed to a normal print gamma of 1.4 (as read by the print-through method*) and should be printed so that the minimum highlight density is above 0.90. This density specification applies to all present emulsions. Introduction of new films now contemplated for this purpose could lower this value because of a lower toe break in the H&D curve.

Duplicate Negatives should be developed to a control gamma which will reproduce the contrast and gray scale of the original negative. On contact duplicates, this is approximately a gamma of 0.65 as read by the print-through method. On optical duplicates, this is approximately a gamma of 0.55. Negatives should be free of ex-

* *Gammas as Measured by the Print-Through Method:* This value of gamma has been specified because it takes into account variations in printing due to differences in color temperature and specularity of the printing light, difference in intensity level and the linear speed of printers. This is important because these factors are not the same for various types of print films. The print-through gamma may be defined as that gamma value measured when the density of a gray scale is plotted on a horizontal axis, with the densities of the print from the gray scale being plotted on the vertical axis.

cessive abrasion, dirt, drying streaks and water spots. Negatives should be developed with sufficient agitation so that directional effects are minimized.

Prints should be made on a positive stock and developed to a print contrast as required by the photographic contrast of the negative to be printed.

Where the negative is of consistently low image contrast, it may be printed and developed at the normal gamma of approximately 2.35 (gamma as measured by the print-through method). Where the contrast of the negative is of consistently high photographic contrast, it would benefit by being printed and developed to a lower print contrast, which may be as low as a gamma of 1.85 (gamma as measured by the print-through method). This contrast may be achieved by development of films such as Eastman Fine Grain Release Positive Film, Type 5302 or Du Pont Type 825 Fine Grain Release Positive Film to a lower than normal theatrical contrast, or the use of low contrast positive films such as Du Pont Type 824 Fine Grain Low Contrast Positive Film or Eastman Fine Grain Duplicating Positive Film, Type 5365, developed in a normal positive developer.

In the timing of prints, it is recognized that the printer lights for the numerous scenes comprising an edited film are selected from Cinex tests or by visual evaluation of the negative. The resulting print intended for telecasting should appear somewhat higher in density in the highlight areas and somewhat lower in contrast than prints customarily intended for theater projection.

In prints thus timed with proper scene-to-scene balance, the majority of scenes should meet the following quantitative specifications:

Prints should be timed so that the face densities or normal middle-gray points of interest are a density of 0.75 $\pm$ 0.15. The minimum density of any area required to reproduce detail should be 0.40 or above. The maximum black of any area where detail is required should be $2\frac{1}{4}0$ or below.

Prints should be timed so that the scene-to-scene balance of overall density is as uniform as possible.

Prints should be free from any spots, streaks or scratches not present in the negative.

Prints should be surface-treated with a lubricant or other protective treatment to insure smooth projection and to minimize wear and scratches.

The conditions listed above apply with equal validity to prints made in 16mm either by reduction printing or by contact printing from original or duplicate negatives.

Sound Negatives should be processed to negative gammas and densities to give minimum intermodulation distortion results on variable-density and maximum cancellation on variable-area when printed to the proper contrast for the picture in the television print. With 16mm printing, variable-area sound negatives are recommended because of their inherent 5 to 6 db advantage in signal-to-noise ratio. Either 16mm or 35/32mm width film negatives are acceptable for 16mm sound printing.

Leaders should be SMPTE Television leaders with either a print of the sound negative or black-printed in the sound area starting at least 20 frames ahead of the first frame of picture in 35mm and 26 frames ahead of the first frame of picture in 16mm.

COLOR

Photography and Lighting for Optimum Quality

Since there is no provision for contrast control in color film negatives or prints available for use, more of the burden of producing acceptable color prints for TV falls on the photography and lighting. The lighting contrast should be kept to a level of 1.5 to 1 or 2 to 1 and unlit dark areas should be avoided. The exposure of the negative must be very carefully controlled in order to achieve maximum color saturation.

Most of the practices recommended for black-and-white photography are equally applicable here.

Laboratory Practices

Negatives should be processed as soon as possible after exposure. Developing should be done in accordance with the manufacturer's specifications.

Color Master Positives and/or Separation Master Positives should be exposed with sufficient exposure to insure a linear gray scale. Separation positives should be developed to the control gammas that will produce a balanced color internegative. Color master positives should be processed in accordance with the manufacturer's specifications.

Color Duplicate Negatives and Internegatives should be made on the proper film stock for reproduction from Kodachrome, separation master positives or color master positives. Exposure should be sufficient to insure a good gray scale and give optimum color saturation. Developing should be done in accordance with the manufacturer's specifications.

Prints should be timed so that the prints are dark enough to give good color saturation but not dark enough to make shadows too dense. The equivalent gray density values should be about the same as those given for the best results in black-and-white.

A & B Printing is recommended for the making of dissolves and fades, in the manufacture of prints for TV from original negatives, or for the making of color master positives. This practice avoids the use of second generation material intercut with the original material, which causes desaturation and mismatch of colors.

Black-and-White Prints from color negatives should be made by first making a panchromatic master positive from the color negative, in accordance with the gamma and densities as set forth for a normal black-and-white positive. A duplicate negative is then made as with a normal master positive. The black-and-white prints are made from this duplicate to television specifications as outlined previously.

All of the other practices as outlined for black-and-white laboratory procedures apply also in color, 35mm and 16mm.

The Optics of the Lenticular Color-Film Process

By RUDOLF KINGSLAKE

Although lenticular film is not new, it has become a subject of current interest as a possible new tool for color television. This paper provides a basic description of the film and its associated equipment, and reviews the capabilities and limitations of this method of recording color information on black-and-white emulsion. Differences in technique and new equipment requirements peculiar to lenticular film are covered from an overall system viewpoint. Filter requirements and lens design are outlined, as are possible designs for cameras, projectors, printers and viewers.

THE lenticular color-film process was apparently first suggested by Rodolphe Berthon[1] in 1909. He proposed that a great number of hexagonal lenticules should be formed on the back of the base of a photographic film, the lenticules facing the taking lens in the camera or the projection lens in a projector. By a correct choice of the radius of curvature of the lenticules, each lenticule can be made to form a sharp image of the lens aperture on the emulsion. If the lens aperture is now divided into three areas covered respectively with filters transmitting the primary colors red, green and blue, then three minute areas illuminated respectively with red, green and blue light will be formed on the emulsion under each lenticule.

Suppose that the film is placed in a camera, the three filters being in position, and that the image of a red object falls on one of the lenticules. Only the red filter on the lens will now transmit any light towards that particular lenticule, and the area of the film beneath the lenticule which receives the image of the red filter will be darkened, the other parts remaining clear. Upon reversal or printing of the film, the exposed area under the lenticule will become clear and the remaining areas will become dark. On replacing the film in its original position relative to the lens, and projecting light through the film towards the lens, the clear area beneath the lenticule will be projected back on to the red filter, and red light will fall on the screen. Thus a lenticular film carrying only black-and-white silver images can be used to record and project colors by an additive system.

If the lenticules are hexagonal, each lenticule represents a unit of definition in the image, and any desired arrangement of the filters in the plane of the lens aperture may be used. However, as Berthon pointed out, it is much simpler to make cylindrical lenticules running across the film area, and in that case the filters must consist of straight bands lying across the lens aperture in the same direction as the lenticules on the film. An iris diaphragm cannot now be used to stop-down the lens aperture or it would trim off the outer filter bands and destroy the color reproduction completely; some kind of slit or "rat-trap" diaphragm must be used in which the aperture is reduced only along the length of the filter bands.

Since the announcement of Berthon's invention, an enormous amount of time and money has been spent on attempts to overcome the many difficulties inherent in the method and make it work as a practical motion-picture process.[2–5] Hundreds of patents have been taken out on every conceivable aspect of the problem; yet in spite of all this activity it has never been used on a commercial scale in theaters. In 1928, the Eastman Kodak Company announced the "Kodacolor" process for taking and projecting lenticulated 16mm color film.[6] The process remained in regular use for about seven years, after which it was completely replaced by the subtractive monopack Kodachrome film. Last year, the lenticular process was revived for use in the kinescope recording of color-television images,[7] with sufficient success to justify a reconsideration of the fundamental optical problems inherent in the lenticular process itself.

The Lenticules

Assuming that the thickness of the film is 5.6 mils (= 0.0056 in.), and that its refractive index is 1.5, we may use the familiar formula connecting the object and image distances of a single refracting surface, namely, $n'/l' = n/l + (n'-n)/r$ to determine the necessary radius of curvature for the lenticules. Since any practical camera or projection lens will virtually be infinitely distant as compared with the dimensions of the lenticules, and since the image distance l' must be equal to the thickness of the film base, we find that the lenticular radius r must be equal to one-third of the film thickness, namely, 1.87 mils. The focal length of this little lens (in air) is 3.73 mils, and if we decide that, in order to be invisible, the width of each lenticule shall be at most 1/25mm (= 1.57 mils), then the relative aperture of the lenticules works out to be about $f/2.3$. The diagram in Fig. 1 shows lenticules having the relative dimensions stated here.

The resolving power of the emulsion must, of course, be equal to or better than the dimensions of the images of the filter bands formed beneath the lenticules. Thus if a three-banded filter is used, the resolving power must be at least 75 lines/mm, and this is the minimum possible requirement. It is difficult to manufacture a fast negative-type emulsion having adequate resolution and sufficiently low diffusion properties for use in the lenticular process.

The location of the focal plane of the camera and projector lenses in relation to the lenticules and the emulsion surface is not easily defined. In the plane of the usual diagram (Fig. 2), the image should obviously fall on the lenticules themselves in order to secure the sharpest possible definition. In the perpendicular meridian lying parallel to the axes of the cylindrical lenticules, in which the lenticules exert no lens power, the image plane should be located at a point $\frac{2}{3}$ of the distance from the lenticules to the emulsion in order that it will be imaged sharply on the emulsion itself after passing through the film base. Since both of these conditions cannot be met simultaneously, it is probably best to compromise between them, in which case the plane of best average definition will lie approximately in the plane of the centers of curvature of the cylindrical lenticules, situated at $\frac{1}{3}$ of the distance from the lenticules to the emulsion.

Choice of Filters

In projection of lenticular films it is theoretically possible to use filters which

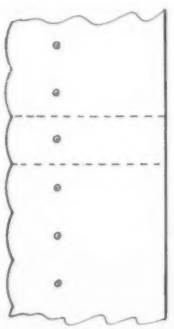


Fig. 1. The relative dimensions of the lenticules.

Presented on Oct. 5, 1957, at the Society's Convention at Philadelphia by Rudolf Kingslake, Eastman Kodak Co., Apparatus and Optical Div., 400 Plymouth Ave. N., Rochester 4, N.Y.
(This paper was received on September 5, 1957.)

transmit only three "monochromatic" spectral primaries. However, the severe shortage of light in projection generally forces us to depart drastically from this condition, and the filters actually used in projection are governed more by practical considerations such as a low fading characteristic and a high overall light transmission. The colors of the three filters should be spaced as widely as possible in order to be able to reproduce the greatest possible gamut of colors appearing in the subject. Once the projection filters have been chosen, then an appropriate set of camera filters must be selected. The transmittance curves of these camera filters, after multiplication by the emulsion sensitivity, should be equal respectively to three linear combinations of the three tristimulus curves of the eye, the actual combinations depending upon the particular projection filters used. The best available filters will, of course, be only an approximation to this desideratum.

The freedom to vary the filters in both camera and projector is one of the advantages of the lenticular system; the other advantages are the low cost of materials and the high permanence of the (silver) images.

Because of the inevitable diffusion of a photographic emulsion, the filter images are liable to spill over into the space properly belonging to the neighboring filters causing a loss of color saturation. This effect may be minimized by leaving black safety gaps between the filter bands in the camera and in the projector. Furthermore, by using two blue filters, one at the top and one at the bottom of the lens aperture (Fig. 3), any bleeding of the image from one lenticule to the next on either side of it will cause no trouble because the blue image under one lenticule will then diffuse into the blue image under the next lenticule. In additive color systems, blue is necessary for good color rendering but contributes very little to definition. The outer zones of the lens are liable to have more aberrations than the inner zones, which is yet another reason for placing the blue filters in the outer parts of the lens aperture. It should be noted that in projection, the separate filter images under the lenticules are projected into the lens aperture by the lenticules themselves, where their images may be examined on a white screen if desired.

Location of the Filter Bands

The filter bands must be located in one of the pupils of the lens since the pupils are effective aperture stops situated at the points where the principal rays of oblique beams cross the lens axis. The exit pupil of a lens is the common base of all the cones of rays proceeding from the lens to the various points in the image surface. If the exit pupil lies between the back of the lens and the focus, the filters

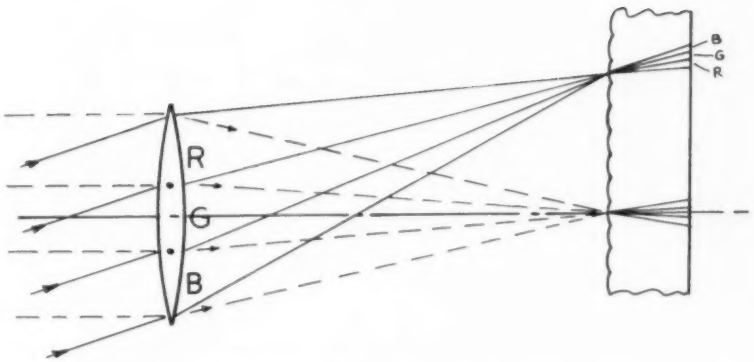
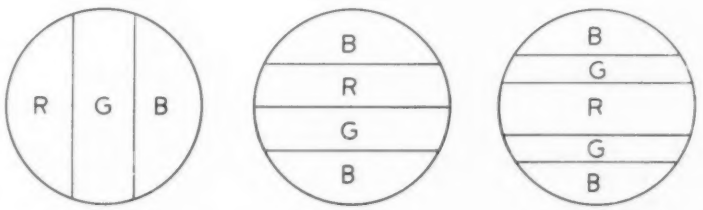


Fig. 2. Indicates why the filter bands must be in a fixed position relative to the film.



(a) Original Kodacolor **(b) Color Television** **(c) Experimental color film**

Fig. 3. Some typical arrangements of the filter bands at the lens aperture.

can be placed directly in the plane of the exit pupil itself. Much more frequently, however, the exit pupil is a virtual image of a real diaphragm situated somewhere inside the lens, and in that case the filters would be located at the plane of this internal diaphragm so that their images would lie in the exit-pupil plane. However, the most important fact to notice in this regard is that *the distance from the film to the exit pupil must be constant in any one complete lenticular color system.* This means that all the lenses used in the system, in cameras, projectors and printers, must have their exit pupils at the same distance from the film. The reason will be clear from Fig. 2, which shows the path of an oblique light beam into or out of the film. Failure to match the exit-pupil distances perfectly in camera and projector will lead to a loss of color purity at the top and bottom of the projected picture (assuming horizontal lenticules are used) because the various image elements in the emulsion would then be imaged on the wrong filters in the projection lens. If the exit pupil is at a finite distance from the film, the lens axis must pass through the exact center of the frame. This will prevent moving the film in the projector gate in order to frame the picture on the screen; it would also eliminate the possibility of continuous printing on a moving film.

Although the precise value to be adopted for this constant exit-pupil distance from the film is arbitrary, it is very desirable for the two reasons just given to make this distance infinite. A lens with an infinitely-distant exit pupil is said to be "telecentric." In such a lens the middle rays of the emerging light beams are everywhere perpendicular to the film surface, and the film can be moved vertically or horizontally without any variation in the color reproduction conditions.

In a telecentric lens, the entrance pupil and the filter plane generally fall at the anterior focus of the lens (Fig. 4). It is not easy to design telecentric lenses meeting this condition, although a number of designs have been described in the literature.* The lens itself tends to become very large to avoid excessive vignetting of the oblique pencils. Many projection lenses of the modified Petzval type (two cemented doublets widely spaced) have the anterior focal point situated so close to the front lens vertex that they can be used as telecentric systems over a semi-field-angle limited to about five or six degrees. The lenses used in commercial contour projectors are usually telecentric, but their low relative aperture ($f/10$) makes them quite useless with lenticular films since the lens aperture must be at least equal to the lenticular aperture, or $f/2.3$.

If a suitable telecentric lens is available for a camera or projector (focused on

* See, for instance, Grosset, Hudeley and Lagrave, U.S. Pat. 2003881; Aklin, U.S. Pat. 2559836; Tiller and Schulz, U.S. Pat. 2603127; Tiller, U.S. Pat. 2651970; Schulz and Seibert, U.S. Pat. 2685229; Coleman, U.S. Pat. 2687063; Hacman and Klemt, U.S. Pat. 2718173; Tiller, U.S. Pat. 2737849; Tiller, U.S. Pat. 2764912.

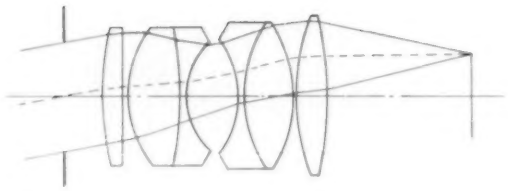


Fig. 4. A typical f/2.3 telecentric lens (from U.S. Pat. 2,003,881).

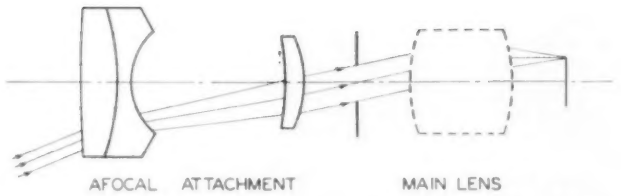


Fig. 5. The use of a Galilean telescope before the telecentric stop to change the focal length of a lens.

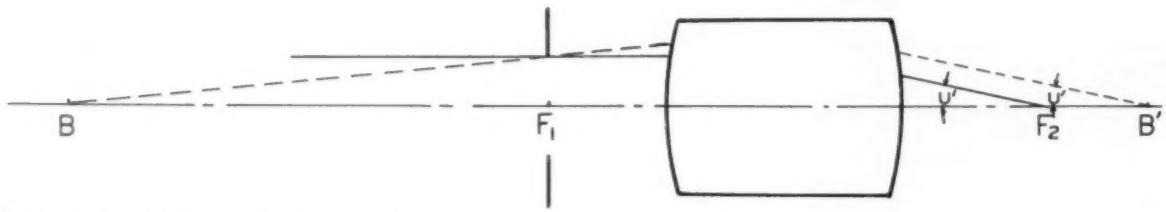
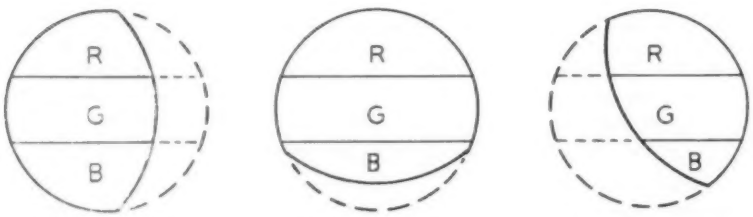


Fig. 6. A telecentric lens used with a near object.



(a) Extreme left of gate (b) Top of gate (c) Upper right corner of gate

Fig. 7. Effect of lens vignetting when a 3-band filter is used.

infinity), the focal length may, if desired, be changed by adding direct or reversed afocal Galilean telescopes ahead of the filter bands, since the addition of these attachment lenses will affect neither the telecentric character nor the relative aperture of the main lens (Fig. 5).

An interesting incidental property of a telecentric lens is that its effective *f*-number in the image space is independent of the distance of the object. The reason for this is shown diagrammatically in Fig. 6. The marginal rays starting from a series of different object distances intersect each other at the rim of the diaphragm, and because the diaphragm lies in the anterior focal plane of the lens, these marginal rays emerge at the same slope-angle U' in the image space. Since the effective *f*-number of a lens is given by $1/(2 \sin U')$, the effective *f*-number of a telecentric lens is independent of the object distance. This property does not hold for non-telecentric lenses.

The Effect of Vignetting on Color Rendering

The distribution and widths of the three primary colors, red, green and blue, in the filter bands is arbitrary, and in the 16mm "Kodacolor" lenticular process the three bands were approximately equal in width, with the green band central and the red and blue bands on either side of it (Fig. 3a). In this process, the lenticules and filter bands were vertical. However, this arrangement is unsatisfactory if the lens shows a significant amount of vignetting of the oblique light beams. Suppose the lenticulations are horizontal, and the filter bands are also horizontal (Fig. 7); then at all image points to left and right of center, the vignetting will trim the upper and lower bands a little more than the central band, so we should expect the left and right sides of the picture to be slightly greenish in color. At the top of the frame, the blue (bottom) filter would be almost entirely removed, giving a yellow color, while at the bottom of the frame, the red would be removed, leading to a cyan color. This situation can be much improved by using a four- or five-band filter, with two blue bands situated at the top and bottom of the aperture. Then at the top and bottom of the frame the entire blue component of the picture will not be removed, but at most half of it, thus improving the situation there very greatly.

Color Fringing in the Camera

When lenticular film is used in a camera to photograph objects at a variety of distances, it is possible to focus objects at only one distance sharply on the film. When the imaging cone for an out-of-focus object point reaches the film it has either not yet come to focus or it has already passed through its focus. The red, green and blue parts of the beam will therefore be somewhat separated at the film plane, causing color fringing of the images of all out-of-focus objects, the width of the color fringe depending on the distance of the object in question from the sharply focused plane.

By the use of beam-splitters in front of the filter bands on the camera lens, Fig. 8, it is possible to convert these color fringes into an out-of-focus white image, so that there will then be no difference between an out-of-focus image on lenticular film and one on any other kind of color film. In this figure, suppose that the lens is correctly focused for a very distant object. Then parallel rays entering the three filters via the prismatic beam-splitters will all come to a common focus at F. However, a relatively near object P will give a diverging beam, which will be split into three equally diverging beams passing through the three filters as shown. Now the upper rays a_1, a_2 and a_3 of the three diverging beams are parallel to each other, hence they come to a common focus at a'. The lower rays b_1, b_2 and b_3 come to a common focus at b', and so on for all the other rays in the beam. Hence the whole beam builds up a white patch from a' to b' in the film plane, absolutely free from any signs of color fringing. Furthermore, the reduction in the vertical aperture of the lens will effect a substantial increase in depth of field, but at the expense of lens speed.

Because of the many problems involved in using lenticular film in a camera, it has been proposed to use this material only for projection. The original camera nega-

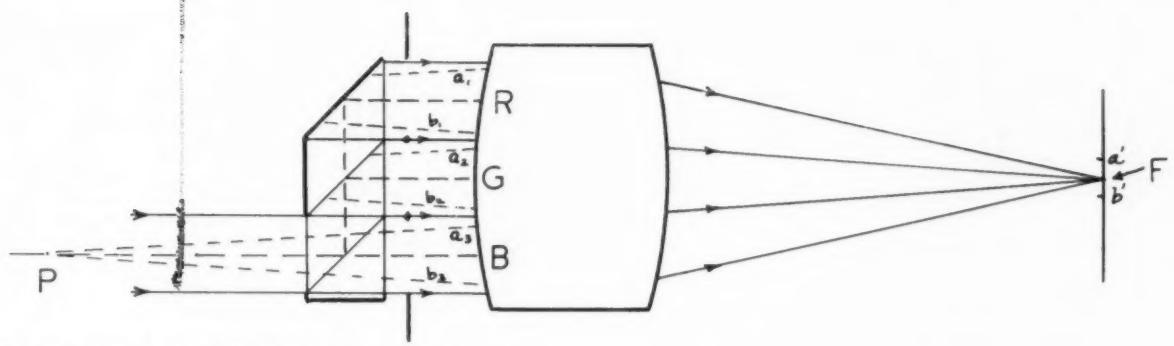


Fig 8. An anti-color-fringing device for a lenticular camera.

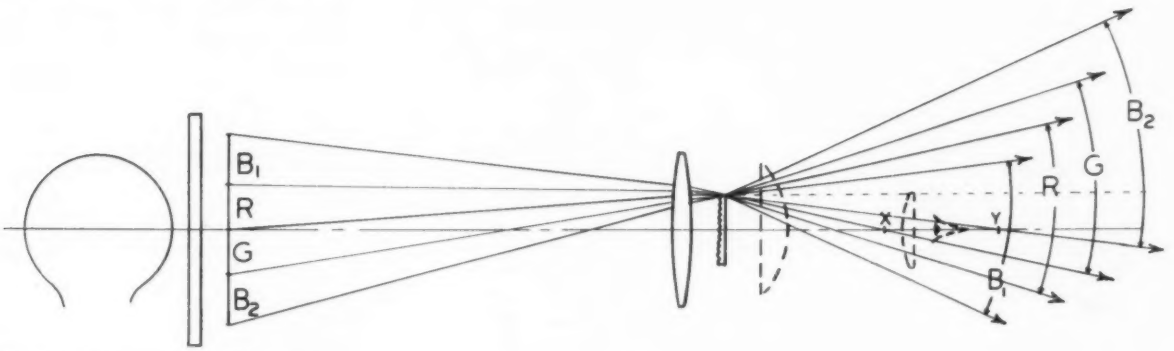


Fig. 9. A color-restoring film viewer.

tive would then be made by some type of optical or mechanical separation of the color negatives, or on monopack color film, but the great loss of light in projection makes even this a difficult process to accomplish satisfactorily.

The Spreading of a Light Beam by a Lenticular Film

It is a fundamental law of optics that the extreme limiting ray of a beam with an f-number N, has a slope equal to $\sin^{-1}(1/2N)$. For an $f/2.3$ cone, this slope-angle amounts to $12\frac{1}{2}°$. Thus, any narrow parallel beam of light falling on a single lenticule will emerge on the other side of the film as a fan covering an angle of $\pm 12\frac{1}{2}°$ centered about the direction of the incident light. Furthermore, if a full $f/2.3$ cone of light falls on an $f/2.3$ lenticule, the emerging beam will enclose an angle of $\pm 25°$ ($f/1.2$).

A Color-Restoring Film Viewer

By the aid of this convenient device, it is possible to view a piece of lenticular positive film in its correct coloring. A set of filter bands is mounted at the focus of a collimator lens, the filters being transilluminated by a lamp and opal glass (Fig. 9). The film is placed close to the collimator lens with the lenticules facing the light source. By the argument of the last section, it will be clear that the light beams from the four filter bands will be spread out by the lenticules themselves into four overlapping fans, shown clearly in Fig. 9, and hence if the eye is placed on the axis of the system at any point beyond Y, then light from all four filter bands will enter the eye. However, if the eye is placed on the axis between the points X and Y, the red and green beams will be properly received and also one blue beam, giving a blue-deficient but otherwise correct color rendering. At a point closer to the film than X, no green will be seen.

It is convenient, but not actually necessary, to mount a large Ramsden eyepiece behind the film to magnify it somewhat (indicated schematically in Fig. 9), but care must be taken to verify that the eye is placed beyond the image of the point Y formed by this eyepiece.

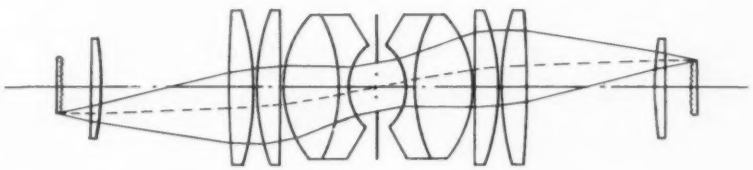


Fig. 10. A symmetrical telecentric printer for lenticular film.

Printing Lenticular Films

(*a*) *Direct Optical Printing:* If lenticular color film is to be used in both a camera and a projector, it is necessary to provide means for making positive prints from the camera negative. In principle, the simplest way of doing this is to provide a symmetrical printer with a central stop, each half of which is telecentric. The optical system would therefore be a unit-power afocal telescope (Fig. 10). Each half of the printer system must have a relative aperture equal to the lenticular aperture ($f/2.3$), and of course there should be no vignetting. The focal length of each of the two half-systems may have any convenient value but it must be the same for both. The illumination on the negative film should be diffuse, or if specular it should ideally be telecentric but this is not an absolute requirement. As a single narrow beam falling on one lenticule of the negative film is dispersed by that lenticule into an $f/2.3$ fan, the relative aperture of the illuminating beam itself is unimportant. No color filters are necessary in this type of optical printing; it is, however, desirable to insert a mask at the internal telecentric stop between the two halves of the printer lens, carrying openings corresponding in size to the color filters used in the camera and projector. Because of moire effects and other difficulties, printing in this manner has proved to be relatively unsatisfactory.

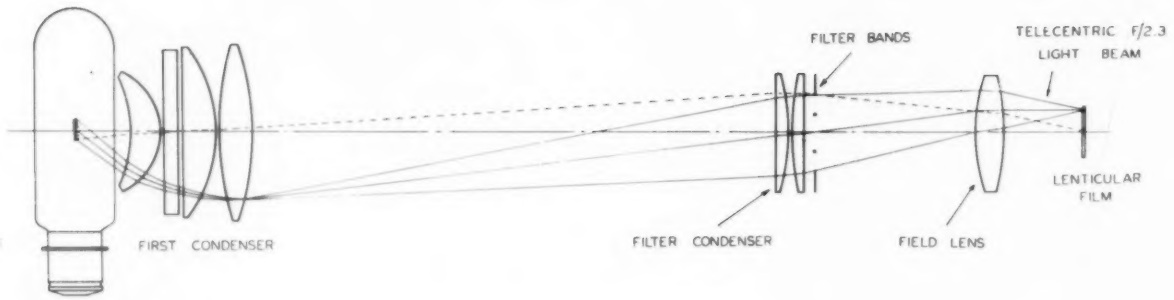


Fig. 11. A color-restoring illuminating system.

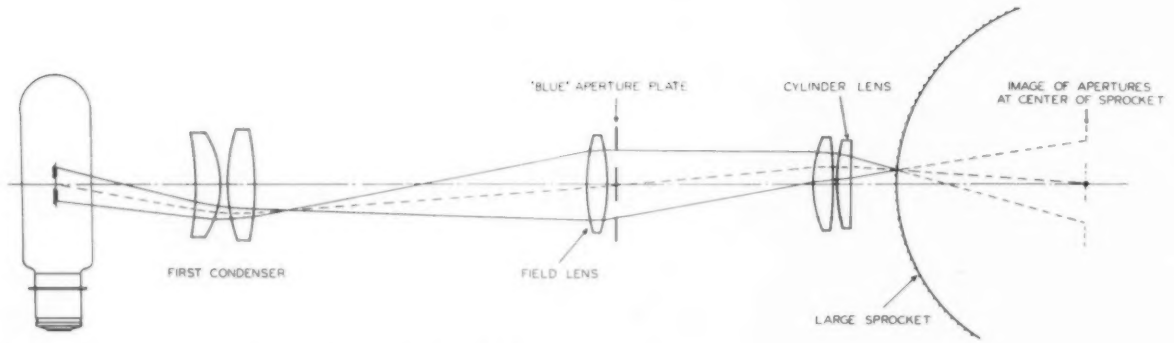


Fig. 12. Illuminating system for a rotary contact printer.

(*b*) *A Color-Restoring Printer:* By means of a suitable illuminating system, embodying correctly placed filter bands, it is possible to restore the colors to a lenticular film using a specular beam. The colored reproduction may then be rephotographed on another lenticular film, the lenticules of which may have any spacing or any orientation, or on a negative or positive monopack color film, or in any other way. The optical system required to restore the colors in a lenticular film is generally a relay-type condenser in which the light source is imaged by a first condenser on the filter bands (Fig. 11). The filter bands themselves are placed at the anterior focus of a field lens close to the film gate, a second "filter-lens" being placed in front of the filter bands to image the aperture of the first condenser on the film gate. The lenticules must, of course, face the light source when this arrangement is being used. The first condenser must be very strong and also large, and it is generally placed at a considerable distance from the filters in order that the image of the lamp filament may be large enough to cover the filters completely. A heat-absorbing glass is very necessary to avoid damage to the filters by the heat of the filament image which is focused directly upon them. The focal length of the field lens should be short so that small filter bands may be used, but in that case the relative aperture of the field lens will be high as its linear diameter is determined by the size of the film gate. Such an illuminating system must be carefully designed, and a makeshift system is unlikely to be satisfactory.

Any desired camera lens may be used to photograph the "color-reconstructed" film, provided it is placed beyond the point Y in Fig. 9 to ensure that light from all four filter bands will enter the camera lens. If it is desired to place the camera lens closer to the film, a field lens may be mounted behind the film to move the point Y closer to the gate.

(*c*) *Printing on Lenticular Film From Separation Negatives:* If a set of three color-separation negatives is available, they may be printed consecutively on lenticular positive raw stock, either optically using a printer lens which is telecentric in the image space, or by contact. Contact printing is the quickest method, but care must be taken to secure correct optical conditions. The separation negatives must be on a low-diffusion type of emulsion, the negative film must be pressed closely against the lenticules of the raw stock during printing, and the light must come from a small source located at the midpoint of the filter band corresponding to the particular separation negative being printed. There will be a loss of definition along the length of the lenticules due to the thickness of the film base unless the source of printing light is very narrow in that direction; however, there will be no loss due to the film thickness in the perpendicular meridian. Hence the light source can be a narrow line of light at the focus of a collimator, the length of the line being $f/2.3$, with means provided for isolating the red, green, and blue sections of the light source as required. A convenient procedure is to use a linear source of light mounted vertically, and form an image of this in the plane of the filter apertures, where masks can be used to isolate the apertures corresponding to any one color.

If a rotary printer is desired rather than one having a flat gate, the separation negative and raw stock are laid together on a large sprocket; an additional cylindrical field-lens is added to make the principal rays of the printing beams everywhere perpendicular to the film surface. It is clear from the diagram in Fig. 12 that in the absence of any films, an image of the filter masks will be formed at the center of rotation of the large printing sprocket.

The Projection of Lenticular Film

In principle. the correct procedure for projecting lenticular films is to equip the projector with a specially designed telecentric $f/2.3$ projection lens, with filter bands in its anterior focal plane (Fig. 13). However, such lenses are not readily available, and they would be considerably larger and more expensive than the $f/2$ projection lenses ordinarily employed in theaters. The usual compromise procedure is therefore to mount a set of filters at approximately the front focal plane of a normal projection lens, the

inner red and green filters having the correct height while the outer blue filters are somewhat oversized. Thus at the top and bottom of the gate, vignetting in the lens will trim one of the blue filter areas, but the other blue filter will transmit a small amount of blue light from the adjacent lenticule. Since blue contributes mainly to color and very little to definition, this system is found to be satisfactory. The light from an arc lamp with a mirror condenser is sufficiently close to being telecentric. However, if a lens condenser is used, it is helpful to use a collimator near the gate to form an image of the condenser aperture at infinity (*see* ref. 8, p. 124).

Some workers have favored the color-restoring type of illumination indicated in Fig. 11, with the lenticules facing the light source and the filters between the light source and the film. The heat and dirt of the arc lamp become a serious problem when this type of illumination is used.

There is really no mystery about the optics of the lenticular film process. The only fact to remember is that the filter bands must always appear to be at a constant distance from the film (generally infinite), and that the lens aperture must always be equal to the lenticular aperture ($f/2.3$). If these two conditions are faithfully observed, no serious difficulties are likely to arise in this type of color photography.

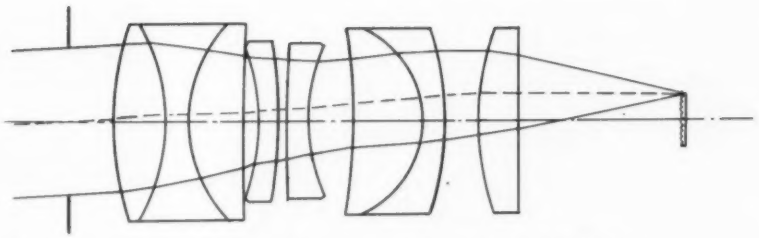


Fig. 13. A typical telecentric projector lens (from U.S. Pat. 2,559,836).

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Devices for Making Sensitometric Exposures on Embossed Kinescope Recording Film

By EDWARD M. CRANE and C. H. EVANS

Two different sensitometers are used in the Kodak Research Laboratories for making test exposures on Eastman Embossed Kinescope Recording Film, Type 5209. One of these instruments which is designed to simulate practical color-kinescope recording conditions quite closely, uses an RCA Type 5ZP16 kinescope as the light source. The other, designed for convenience and repeatability of performance, employs filtered light from a photographic "speedlight," or electronic flash unit. Special features of the sensitometers are discussed, and some test procedures are suggested.

THE PRINCIPLES OF color kinescope recording on embossed film have been described by Evans and Smith.[1] To review briefly, an original subject is analyzed by the color-television system to furnish red, green and blue video signals. Corresponding separation images are displayed in monochrome on three RCA Type 5ZP16 kinescopes. By a system of mirrors and a single objective lens, shown in Fig. 1, these television images are then focused in register on a single frame of Eastman Embossed Kinescope Recording Film, Type 5209. This film has hundreds of tiny cylindrical lenses, or lenticules, embossed on its base, and is loaded in the camera with its base toward the objective lens. Light from each of the kinescopes passes through its own special limiting aperture before reaching the objective lens. This "recording aperture" is nominally identified as "red," "green" or "blue," according to the particular optical path in which it is located. The red recording aperture is defined by the boundaries of a mirror placed just above the optical axis of the objective lens, at its front focal plane. This mirror directs light from the kinescope displaying red information — the red separation — into the objective lens. Similarly, the green recording aperture is formed by the boundaries of a mirror located just below the optical axis, and directs light from the green separation into the objective. The height of each of these two apertures is an empirically established fraction of the focal length of the objective lens, in this case one-tenth, or $f/10$. The blue recording aperture is divided into two parts, one lying above the red aperture and the other lying below the green aperture. An image of each recording aperture is focused by each lenticule into a specific area of the emulsion lying behind that lenticule. Thus, the three color separations presented on the kinescopes are

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(This paper was received on October 9, 1957.)

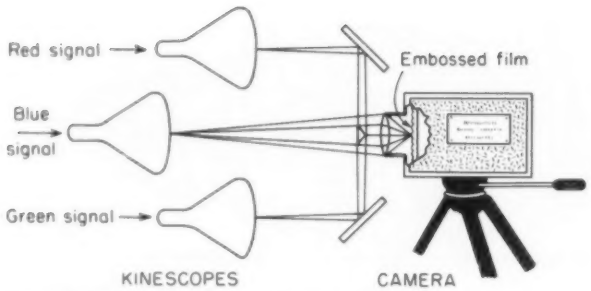


Fig. 1. Color kinescope recording on embossed black-and-white film.

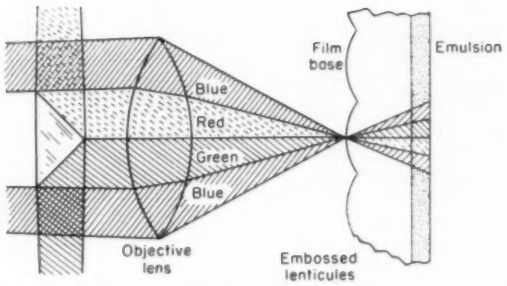


Fig. 2. Enlarged view of embossed film, showing the directive action of a single lenticule.

recorded in interlaced fashion on a single frame of film. The directive action of a single lenticule is shown in Fig. 2, in which some dimensions are grossly exaggerated for clarity.

It is emphasized that the three kinescopes are all showing monochrome pictures by means of an RCA Type P16 phosphor, and the information in each monochrome picture corresponds to a single color aspect (red, green or blue) of the subject being televised. The polarity of the signal applied to the control grid of each kinescope is so chosen that a negative picture is presented by the kinescope. Light carrying the red information passes through an $f/10$ aperture and is recorded in its own area behind each lenticule. The green information passes through an adjacent $f/10$ aperture, and is recorded in an adjacent area behind each lenticule. The blue information passes through the otherwise unoccupied part of the objective lens, and is recorded in the otherwise unused area behind each lenticule.

After exposure, the film is put through a conventional black-and-white development process. The separation images are thus recorded as positives in tiny adjacent strips of metallic silver in gelatin. If a suitable light source is added at the right of the film, and photoelectric cells or other receptors are substituted for the kinescopes, the entire optical system can be operated in reverse to reconstruct the original red, green and blue signals.

Sensitometers and Sources

It has been pointed out by Brown, Combs and Smith[2] that, in any real photographic system, the separation among the three records cannot be perfect. These authors described a densitometer for analyzing the performances of recording chains, films and processes. The densitometer is, in effect, an analytical playback chain. Such an instrument is particularly useful when used in conjunction with a device for making controlled exposures, e.g., sensitometer. In the Kodak Research Laboratories, two different sensitometers are used for embossed film. A sensitometer for embossed film must duplicate, to some extent, the functions of the recording chain. Certain simplifications are, however, not only possible but, from a practical point of view, advisable. For instance, the three signals need not be recorded simultaneously, but can be conveniently recorded sequentially. The three parts of Fig. 3 represent *one* kinescope used as a sensitometric light source, *one* objective lens, and *one* frame of embossed recording film, at three successive times. The signal and the aperture plate are changed between exposures. Positions and sizes of the recording apertures correspond to those employed in the kinescope recording system, but, by way of simplification, two of the kinescopes employed in the recording chain have been omitted from the sensitometer. The kinescope sensitometer is used when it is important to simulate actual recording conditions quite closely.

The problem of obtaining identical sensitometric exposures, time after time, becomes even easier if the remaining kinescope is replaced by a spectrally nonselective light source made to approximate the effect of the kinescope phosphor by means of a Kodak Wratten Filter No. 18A. The light employed in the other sensitometer comes from a commercial 200-watt-second "speedlight," or electronic flash, is diffused by opalized glass, and is filtered by the No. 18A Filter. The intensity of this source is an order of magnitude less than that of a kinescope, and the possibility of reciprocity failure must be taken into account. For many purposes, however, the speedlight sensitometer is sufficient, and is preferred on account of its ease of operation.

Test Objects

Whatever the source, kinescope or diffused and filtered speedlight, it is

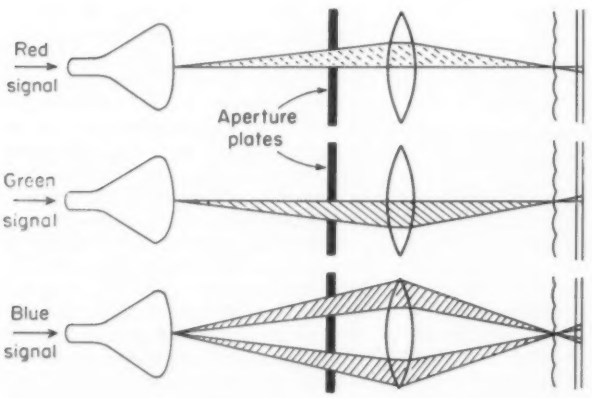


Fig. 3. Sequential recording of red, green and blue separations in kinescope sensitometer.

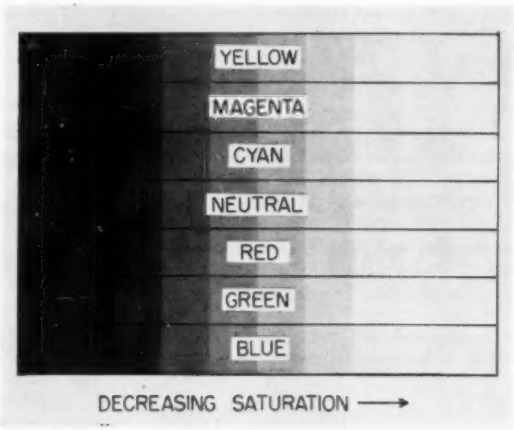


Fig. 4. Sensitometric test pattern.

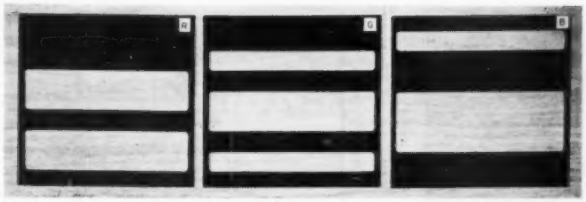


Fig. 5. Field stops ("red," "green" and "blue") employed in sensitometer.

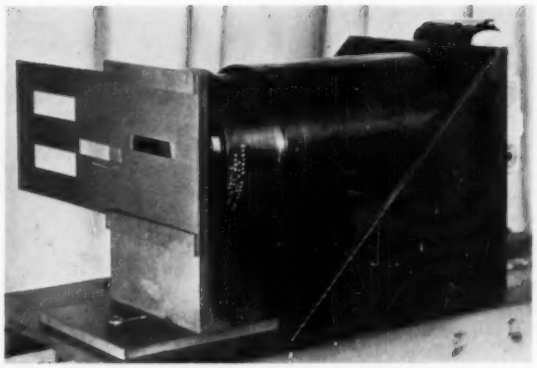


Fig. 6. Recording apertures, objective lens and camera body used in kinescope sensitometer.

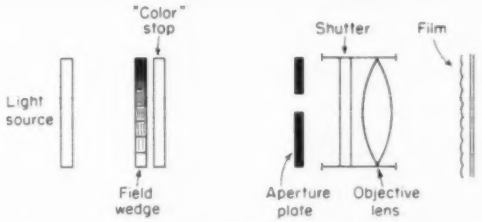


Fig. 7. Schematic diagram of a sensitometer for embossed film.

useful to divide the field of view into small patches. For example, the field may be divided, as shown in Fig. 4, into horizontal stripes, each devoted to a saturation scale in a single color. In the sensitometer-densitometer routine, of course, the so-called "colors" are just identifying tags for geometric positions. Only when the developed film is played back into a color system do the various patches take on color.

Each vertical stripe of the field then comprises a color series at a fixed saturation. The saturation scale is produced by modulation of the electrical input to the kinescope, or by a step wedge of silver in gelatin. Such a step wedge may be placed over the kinescope face, or located between the opalized glass of the speedlight sensitometer and the objective lens (focused on the step wedge). Because of light-scattering in the wedge and flare within the objective, the exposure increments at the focal plane are not accurately known. If absolute values of gamma and speed separation are desired, one test frame should be exposed, emulsion side foremost, to the image of the field wedge, and another to a wedge in contact with the test film. The effective exposure increment of the field-wedge image is then determined by comparison of the two characteristic curves.

To obtain color stripes like those represented in Fig. 4, it is necessary to make exposures to selected areas of the field through each recording aperture. These areas are selected either by electrical modulation of the kinescope presentation or by field stops (Fig. 5), which are successively placed at the plane of the step wedge, with the long dimensions of the openings perpendicular to those of the steps of the wedge.

The film is exposed through the red recording aperture to an image of field stop "R," through the green recording aperture to an image of field stop "G," and through the blue recording aperture to an image of field stop "B." The center stripe is open on all three field stops. Thus, in the center stripe on the film, exposure is obtained through all three aperture plates, and the resulting scale is neutral. The other stripes produced correspond to yellow, magenta, cyan, red, green and blue, as indicated in Fig. 4. Thus the field stops may be considered "color" stops.

Optics and Mechanics

Because the recording apertures of the sensitometer are used in succession, it is convenient to cut them out of a single, thin metal plate which can be indexed to the correct position between exposures. The sliding aperture plate used in the kinescope sensitometer is shown in Fig. 6. One of the interesting questions about embossed film is the effect of leaving unexposed areas between the aperture images in the emulsion. Since the object is to guard against intermixing of adjacent records, these unexposed areas are known as guard bands. They are easily formed in the sensitometer by making the apertures smaller, while retaining the separation of their center lines. The apertures shown in Fig. 6 are used with an objective lens having a focal length of 100 mm. The center-to-center distance between the red and the green apertures is 10 mm., or $f/10$. Each of these two apertures has been narrowed from 10 to 9 mm, and the inner edges of the blue aperture have been moved out so as to furnish 1-mm strips of "no aperture," which, in turn, produce 10% guard bands between aperture images.

The objective lens in Fig. 6 is a special telecentric lens, which was designed by W. E. Schade and constructed by the Apparatus and Optical Division of Eastman Kodak Co. It is corrected for ultraviolet radiation and designed for use with embossed kinescope recording film. Its front focus coincides with its aperture stop, so there is no vignetting of the recording apertures. An ordinary vignetting lens can, however, be employed in the sensitometer because corrections for the effects of vignetting may be applied in order to obtain absolute values of gamma and speed separation.

Some sort of shutter is needed to protect the film between exposures. It has been left out of Fig. 6 so that the apertures will show. In the kinescope sensitometer, the shutter is operated by the "open-flash-shut" technique, while in the speedlight sensitometer a synchronizing shutter is used. Storage and transport of film are facilitated by use of a 35mm still-camera body. Suitable camera bodies are commercially available in the form of 35mm adapters for press and view cameras or enlargers.

The schematic diagram of a complete sensitometer is shown in Fig. 7, and the speedlight sensitometer is shown in Fig. 8. To avoid any possibility of stray light getting into the objective, the entire optical path of the sensitometer, from the field wedge and color stops on, is fully enclosed. Orientation of the camera chosen for this instrument required film transport from left to right rather than from top to bottom, and the recording apertures are therefore rotated 90° about the optical axis as compared with a conventional recording chain. This does not, presumably, affect its performance. The recording apertures are separate; there is no room for a sliding plate. The timer is used to ensure that the capacitor is charged for a standard interval before each exposure so that light-intensity is

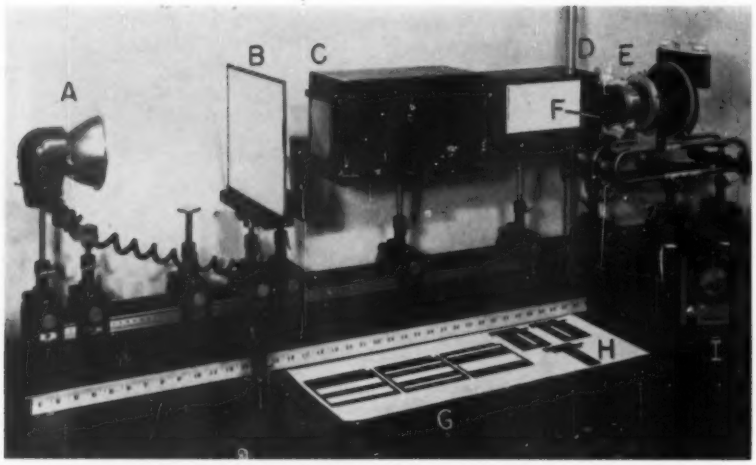


Fig. 8. General view of the speedlight sensitometer: A, source; B, opalized glass; C, field wedge and color stop holder; D, aperture plate holder; E, objective and shutter; F, filter; G, field stops; H, recording aperture plates; I, timer.

constant. This instrument is not confined to use with embossed film. Without the color stops, filter or aperture plates, it becomes a high-intensity sensitometer for other photographic materials.

An Application

Figure 9 is an abstract of a comparison of two embossed films. An intensity scale was recorded on each film through the "red" aperture only, and the films were then processed to negatives. Upon color projection of these films, a saturation scale in cyan is produced. Ideally, there would be no developed silver in the "blue" and "green" areas behind the lenticules, while density in the "red" areas would vary according to the steps of the intensity-scale exposure. Thus, all points of the film would, upon projection, transmit maximum amounts of green and blue light, resulting in a cyan appearance. This cyan would be diluted with red light according to the transmittances of the various recorded steps. A step with very little density recorded in the "red" area would transmit nearly as much red light as green and blue and would therefore be nearly white. Denser steps would transmit less red light, and would therefore yield more saturated cyan color.

Actually, the recorded densities are not confined to the "red" areas, as intended, but spread out somewhat into the adjacent "green" and "blue" areas. This effect increases with increase of the intended exposure, with the result that steps with higher saturation are noticeably darkened because they transmit less

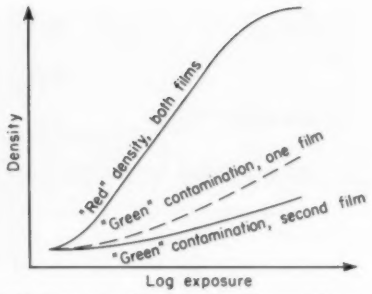


Fig. 9. Comparison of two embossed films, intensity-scale exposure through "red" aperture only.

green and blue light than do the less saturated steps.

The upper solid curve in Fig. 9 represents the densities observed in the "red" areas of the two test films by means of a densitometer fitted with a "red" aperture plate. The dashed curve shows the densities observed in one film with a "green" aperture plate in the densitometer. Exposure from the "red" areas has spread into the "green" areas, producing contamination density. This would not occur in the ideal case, and the dashed curve would then be a horizontal line corresponding to fog plus base density of the film. The lower solid curve shows the "green" densities found in this test on another film. It is obvious that there is less contamination in the second film, and darkening of saturated colors is therefore reduced.

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An Instantaneous Electronic Color-Film Analyzer

By BERNARD D. LOUGHLIN, CHARLES E. PAGE, WILLIAM F. BAILEY, CHARLES J. HIRSCH, ARTHUR J. MILLER and LEONARD GIARRAPUTO

The Analyzer for negative, or positive, color original film displays instantaneously a positive color picture on a color TV tube when a color original is inserted in the device. Color balance and density are adjusted by calibrated controls whose settings are used by a printer to produce a positive closely approximating the displayed picture. The device uses TV techniques to simulate additively the subtractive properties of positive film in spectral taking sensitivities, gamma, contrast and unwanted dye absorptions.

CONTENTS

I. Introduction 17
II. Description of Equipment 17
III. Technical Analog Operation 18
IV. Photographic Printing and Viewing Process to Be Analogued 18
A – Printing • B – Chemical Processing • C – Unwanted Dye Absorption • D – Viewing the Positive Film
V. Electronic Analogs 19
A – Electronic Analog of Exposure to Printing Lights • B – Adjustment of Equipment • C – Analog of Overall Transfer Characteristic (D vs. E) Including Chemical Processing and Viewing
VI. General Requirements for Analog Operation 23
A – Analog of the Printer • B – Transfer Characteristic
VII. Stability and Reliability 24
VIII. Performance and Statistical Results 24
IX. Equipment Specifications 25
X. Experience in the Use of the Color-Film Analyzer 25

I. Introduction

The Hazeltine Color-Film Analyzer supplies directly and immediately the information required for the setting up of film printers to produce high-quality positive prints from negative, or positive, original or intermediate film in color or black-and-white. It can be used with both 35mm and 16mm film and with both additive and subtractive printers.

The "timing" process, now employed for obtaining proper color balance and printing density in positive motion-picture color prints, requires making a first trial print and then additional prints for evaluation and correction by successive approximation until all scenes are satisfactory. These successive approximations result in expensive delays before acceptable prints are obtained and also involve the scrapping of valuable film stock.

The requirement of successive printings can be greatly reduced by electronic techniques based on color-television principles. The Analyzer described here is an equipment of this type. It enables the operator to see instantaneously the effect of various printing-light adjustments on the printed positive and allows him to choose the adjustment which gives the desired color balance and printing density. The printing operation, utilizing the data supplied by the Color-Film Analyzer, will frequently give a high-quality print at the first attempt, and in any case the number of trial prints will be substantially reduced.

Presented on October 3, 1957, at the Society's Convention at Philadelphia, by Bernard D. Loughlin, Charles E. Page, William F. Bailey and Charles J. Hirsch (who read the paper), all of Hazeltine Research Corp., 59–25 Little Neck Parkway, Little Neck 62, N.Y.; and Arthur J. Miller and Leonard Giarraputo, Pathe Laboratories, Inc., 105 E. 106 St., New York 29.
(This paper was received on September 27, 1957, and in final form on November 13, 1957.)

II. Description of Equipment

The original or intermediate film, representing a scene to be "timed," is placed in the television pickup gate, where a television-type scanner produces signals corresponding to the scene. These signals are then electrically modified to reflect accurately the characteristics of the positive film print stock and the effects of the printing and processing operations. The signals are then applied to a color-television picture tube with the proper electrical polarity to afford a positive color view for the observer. Three graduated adjustment knobs enable the observer to vary the color balance and brightness (density) of this television picture, and he adjusts these for the desired reproduction. Scales associated with the knobs then show the adjustments required on the printer to obtain the printing-light quality which will produce this color balance and printing density in the finished positive film.

The equipment (Fig. 1) includes an optical projector which serves as a standardizing means for periodically calibrat-

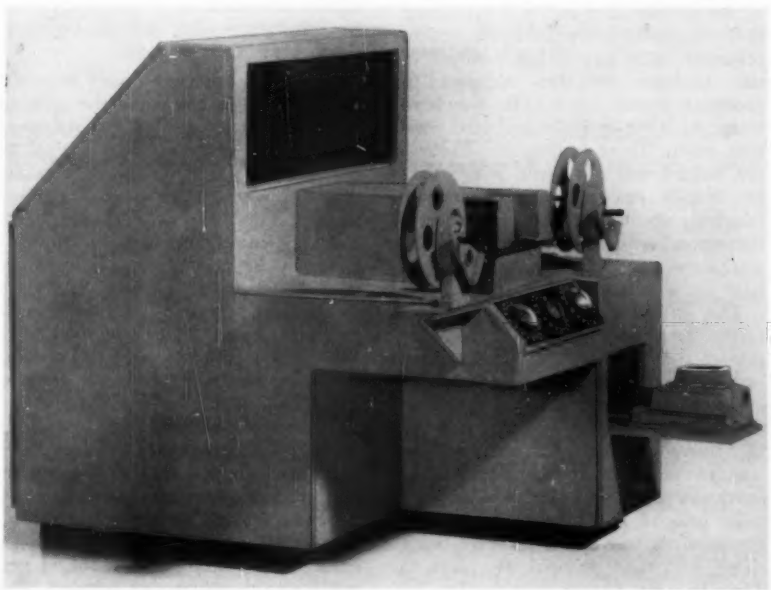


Fig. 1. The Hazeltine Color-Film Analyzer.

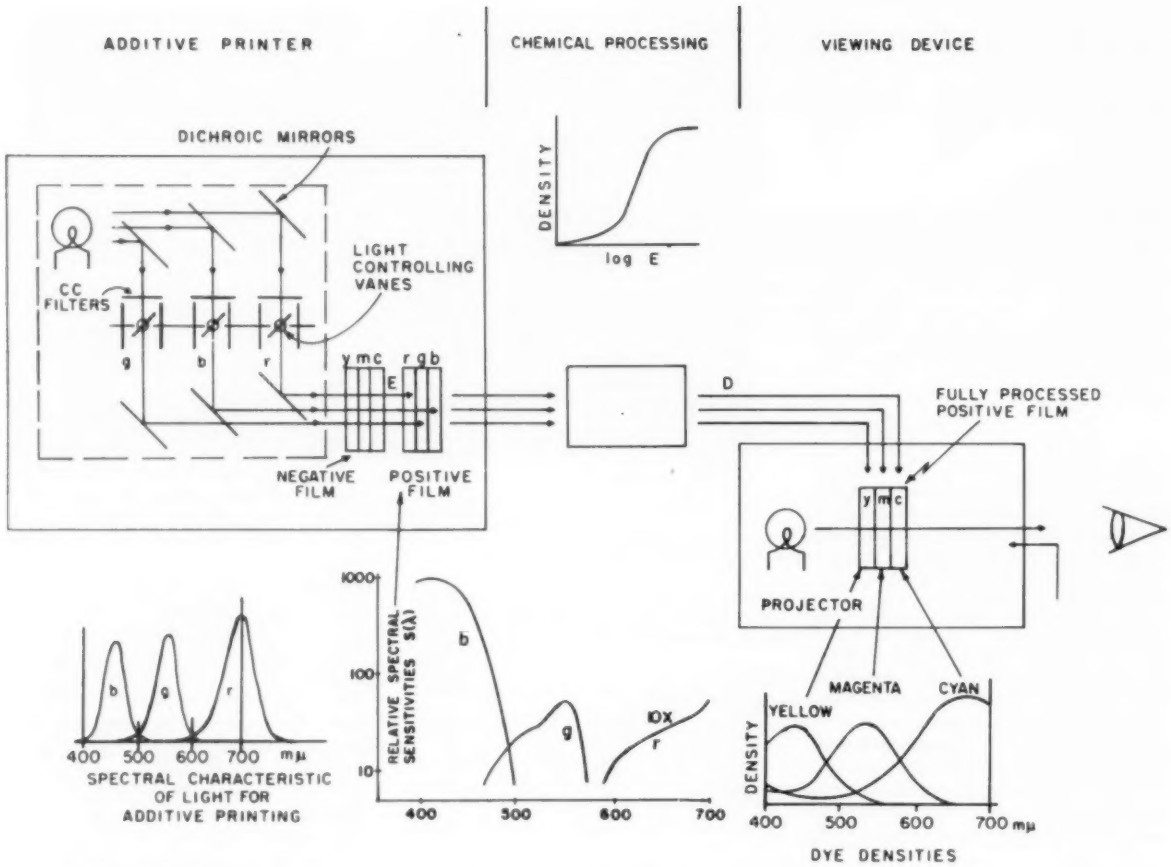


Fig. 2. Photographic system.

ing the electronic equipment. For this purpose a standard reference, original or intermediate film negative or positive, is placed in the television film gate and a positive print, made from this original by the printing and chemical processing to be employed, is inserted in the optical projector. The calibration controls of the Analyzer are then adjusted to provide a precise match of the television image with the optically projected positive print. These calibration controls are located under a cover, where they are readily available to the operator whenever needed. The periodic calibration serves for an initial adjustment of the equipment and to check that adjustments have not changed.

The optical projector may also be used to produce a positive picture at the side of the television picture for comparison to compensate for the adaptation of the observer's eyes to the ambient light condition which could alter his judgment of density and color balance. Positive transparencies of reference scenes of particular types, known to have good color balance although not necessarily the same shot as in the negative being timed, can thus be used as guides to determine the proper reproduction for the scenes in the negative.

III. Technical Analog Operation

The Analyzer operates by creating electrical signals which are analogs of the positive film as it is processed. These signals are modified in successive steps in accordance with the photographic processes.

Since the Analyzer closely parallels the positive film stock and the printing process, it will result in satisfactory prints when used with any original or intermediate film stock — Eastman, Ansco, Gevaert, etc. — which is intended to be printed on: (a) Eastman Color Print Safety Film, Type 5382; (b) Eastman Reversal Color Print Film, Type 5269; and (c) black-and-white print film operating with a gamma between 2.0 and 4.0. Printing stock other than those mentioned and having different characteristics requires an adjustment of the device.

This paper describes the photographic electrical analog, and it is therefore desirable to review the printing process itself to define the characteristics and processes which have to be paralleled. The printing described will be of the additive type although the analog will apply also to subtractive printing. The analog will also be discussed in terms of negative color film although the principle applies equally well for positive color and black-and-white original film.

IV. Photographic Printing and Viewing Process to Be Analogued

A. Printing

Referring to Fig. 2, Block 1 is the printer itself. It provides a light source which is controllable in intensity and chromaticity. For some types of additive printers, it splits light from source A into spectrally narrowband red, green and blue components by means of filters and dichroic mirrors. The intensities of the red, green and blue components of light are controlled in steps by the adjustable vanes, marked *r*, *g*, *b*, which change the size of the aperture through which the light is transmitted. The three components are then effectively recombined into a single beam. The exposure and color balance are controlled by adjusting these vanes. It is the purpose of the "timer" to supply information on how much these vanes should be opened for different scenes so as to obtain the desired quality and color balance in the positive print.

The positive is exposed through the negative to the light of the printer and a

latent image is formed in each of the three layers of the positive emulsion. Since each layer is separately sensitive to red, green or blue, a corresponding color latent image is formed in each layer. The exposure of each layer depends on (1) the spectral dye density of the negative; (2) the *intensity* and spectral characteristics of the printing light; and (3) the *spectral sensitivity* of the individual layer as shown in the block diagram.

B. Chemical Processing

The chemical processing converts the latent images into color images by the formation of a dye having a color which is complementary to the color for which the layer was sensitive and whose concentration increases with the printing exposure. Thus, the blue-sensitive layer receives a yellow dye whose density in blue increases according to the blue exposure. The *density*, D, of the dye deposited is a nonlinear function of the exposure, E. The density increases at first slowly with exposure and then increases more rapidly, forming a *toe* in the D-E curve; beyond the toe, the density increases linearly with the logarithm of the exposure ($D = \log_{10} E$), the slope, γ of this straight line being called gamma. The intersection of the log E axis and the extension of the straight line is called the "inertia." Beyond a certain exposure, the rate of density increase diminishes with increase in exposure, resulting in a knee of the D-E curve. Such a curve plotted in units of D and log E is shown in Figs. 6(b) and (c). The characteristics displayed by such curves are functions of the film and the processing, which must be closely controlled.

C. Unwanted Dye Absorption

Each of the three dyes (yellow, cyan, magenta) is intended to control a region of the spectrum as shown in Fig. 3. Here Fig. 3(a) shows the desired dye characteristic; Fig. 3(b) shows actual dyes and their unwanted absorptions; and Fig. 3(c) shows a simplification of actual dyes into block form to show unwanted absorptions.

Thus, the yellow dye has density to blue; the cyan dye has density to red; the magenta dye has density to green. However, the yellow dye has some unwanted density to red and green. The cyan dye has some unwanted density to blue and green. The magenta dye has some unwanted density to blue and red. Figure 3(b) illustrates the spectral regions of these unwanted densities.

The result is that the transmission of light of any color depends on the *total* density, contributed by all three dye layers, to the light of that color. Thus, the amount of red light transmitted by the positive film is not only a function of the red light transmission of the color

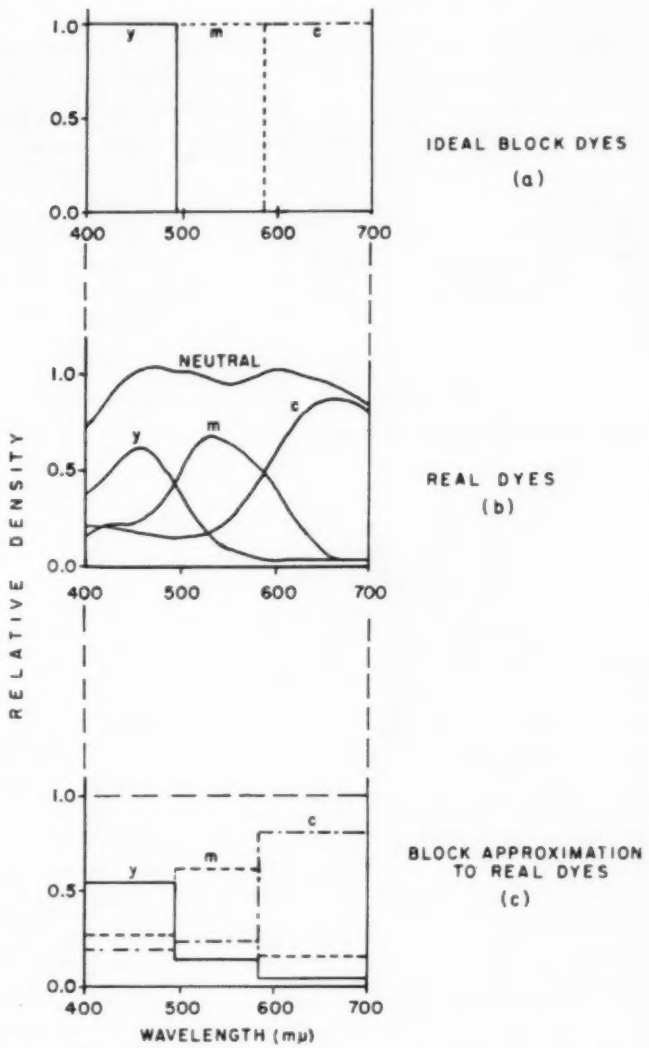


Fig. 3. Unwanted dye absorption: (a) unwanted absorption; (b) block ideal dyes; (c) block dyes with unwanted absorption.

negative, but since it may be modified by the yellow and magenta dyes of the positive, it depends to some extent on the amount of blue and green light transmitted by the negative. A similar consideration applies to the amount of blue and green light transmitted by the positive. This is an undesirable characteristic but *one which the color analyzer must duplicate if the picture it displays is to be a close analog of the picture produced by the positive transparency.*

D. Viewing the Positive Film

The positive film is inserted in a motion-picture projector where it is illuminated by white light. The intensity of the red, green and blue light transmitted by the film depends on the overall density of the film to each color. The relation between relative transmission, T, of light and the density, D, is given by

$$D = \log_{10}(1/T) \tag{1}$$

or, conversely,

$$T = 10^{-D} \tag{1a}$$

V. Electronic Analogs

The electronic analog of the positive film and printing process is diagrammed in Figs. 4, 5, 6, 7 and 9. Figure 4 shows the complete equipment in block form; Fig. 5, the printing analog and exposure controls; Fig. 6, the generation of voltages related to density; Fig. 7, the simulation of unwanted dye absorption; and Fig. 9, the viewing analog.

A. Electronic Analog of Exposure to Printing Lights

Referring to Fig. 5, the negative film (1) is inserted in a film gate where it is scanned by the beam of a flying-spot scanner (2). The light transmitted by the

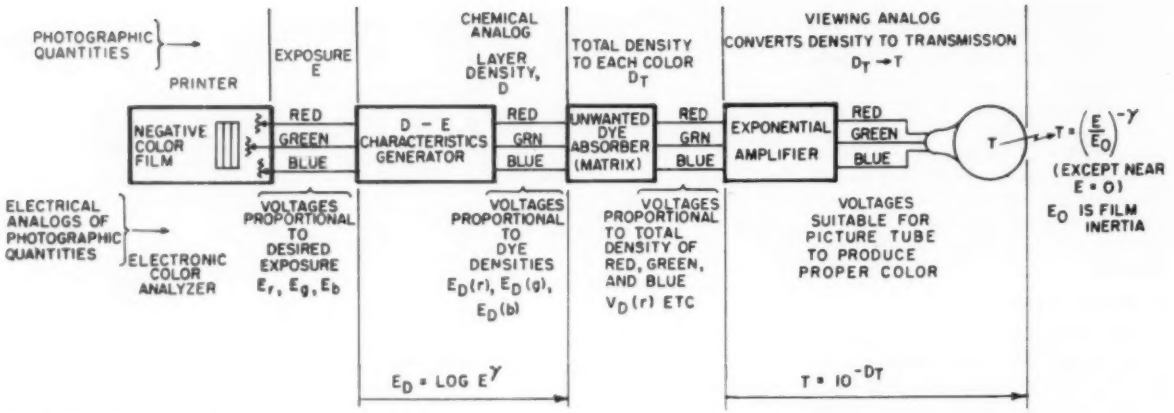


Fig. 4. Electrical analog in block form.

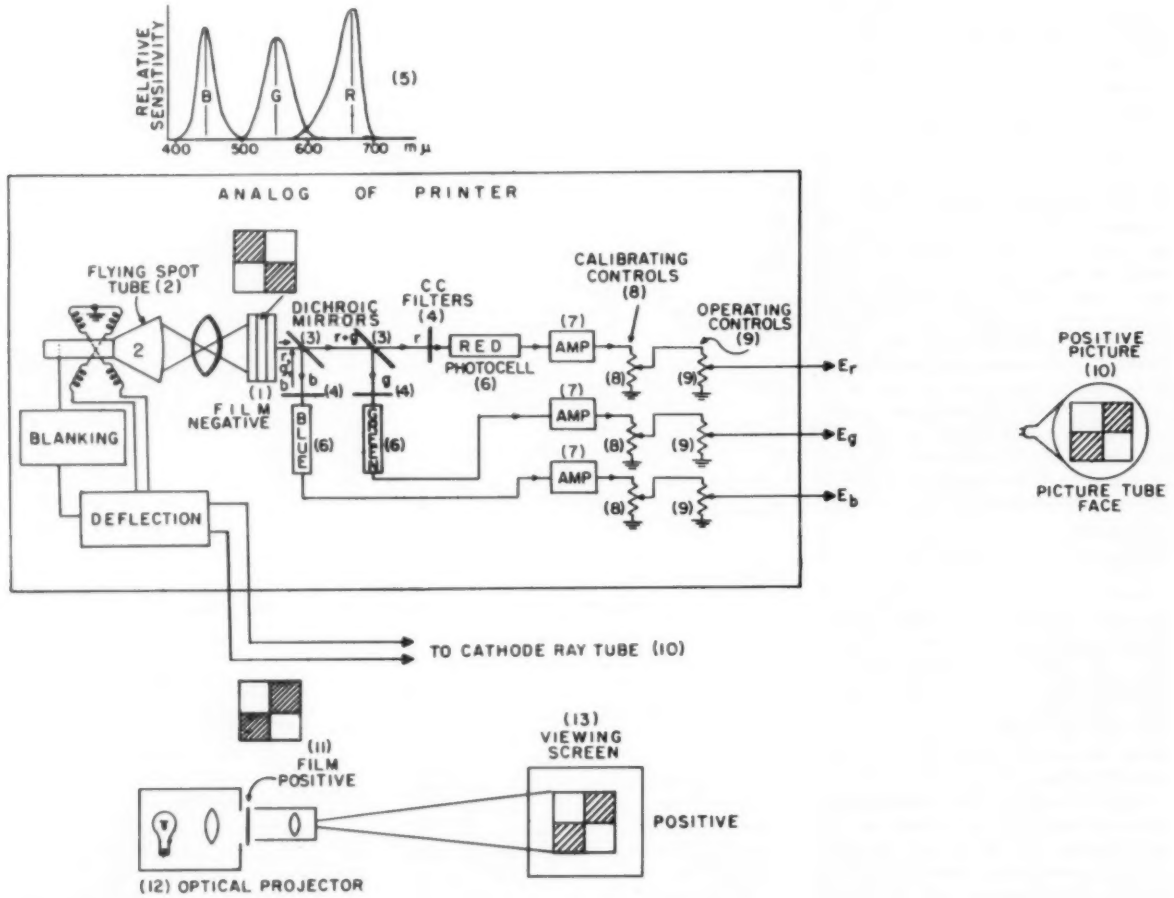


Fig. 5. Analog of printer.

negative is modulated according to the densities of its three layers to each color. It is then resolved into red, green and blue components by dichroic mirrors (3) and color correcting (CC) filters (4). The flying-spot scanner, the dichroic mirrors, trimming filters, and photocells (6) are chosen so that their combined spectral characteristics correspond, as practically as possible, to the *spectral sensitivities* of the layers of the positive stock multiplied by the spectral distribution of the corresponding printing light components (5). The light from each of the three "dichroic mirror–filter" combinations falls on one of three photocells (6) whose output voltage is proportional to the (red, green or blue) exposure of the positive film, through the negative film, and modified by the spectral sensitivities of the positive film.

These voltages, corresponding respectively to the red, green and blue exposures, are then amplified in separate stabilized amplifiers (7) and impressed on attenuators (8) and (9). The three attenuators (8) are used for calibrating

the equipment to the photographic characteristics in a manner to be described in the next section. The three attenuators (9) are used by the operator to control the intensity and color balance of the displayed picture (10) to his taste and are true analogs of the "light-controlling vanes" in the additive printer. The attenuators (9) are calibrated in units of log E. They produce three voltages (E_r, E_g, and E_b) which are quantitative analogs of the intensity of each color component of the printing light used by the printer to make a print which will match the picture displayed on the color television tube (10). The effect of adjusting the attenuator controls (9) is instantaneously displayed on the color TV tube. The range of intended adjustment in log E is ± 0.75 for each color in steps of 0.025. This is a total range of adjustment of 1.5.

When used with subtractive printers, the exposure is controlled by the insertion of CC filters of known density in that part of the light path which is between the film gate and the dichroic mirrors. The values of E_r, E_g, and E_b are also taken from the attenuators which are operated together to adjust the equivalent neutral density.

B. Adjustment of Equipment

To adjust the equipment to the emulsion and processing, a test color negative is inserted in the film gate of the flying-spot scanner. A positive picture is then displayed on the color picture tube. A positive print (11) made from the test negative with the printing and chemical processing to be used, is inserted in the optical projector (12) and displayed on the screen (13). The three attenuators (9) are set according to the relative printing light intensities used in making the positive. The three adjusting attenuators (8) are adjusted to make the television picture (on 10) match the optically projected picture (on 13) in brightness and color as closely as possible. The calibrating attenuators (8) are then locked in position and only the exposure attenuators (9) are used in operation to adjust the density and color balance of the displayed color TV picture. From then on, printed positive film will match the TV picture if the printer is actuated according to the data supplied by attenuators (9).

C. Analog of Overall Transfer Characteristic (D vs. E) Including Chemical Processing and Viewing

The relative luminance in each color emitted by the picture tube can be thought of as being produced by a source of white light of constant intensity and a screen of varying density in red, green and blue. The "effective screen density" of the picture tube with varying *exposure* is made to conform to the D vs. E curve of the processed positive stock.

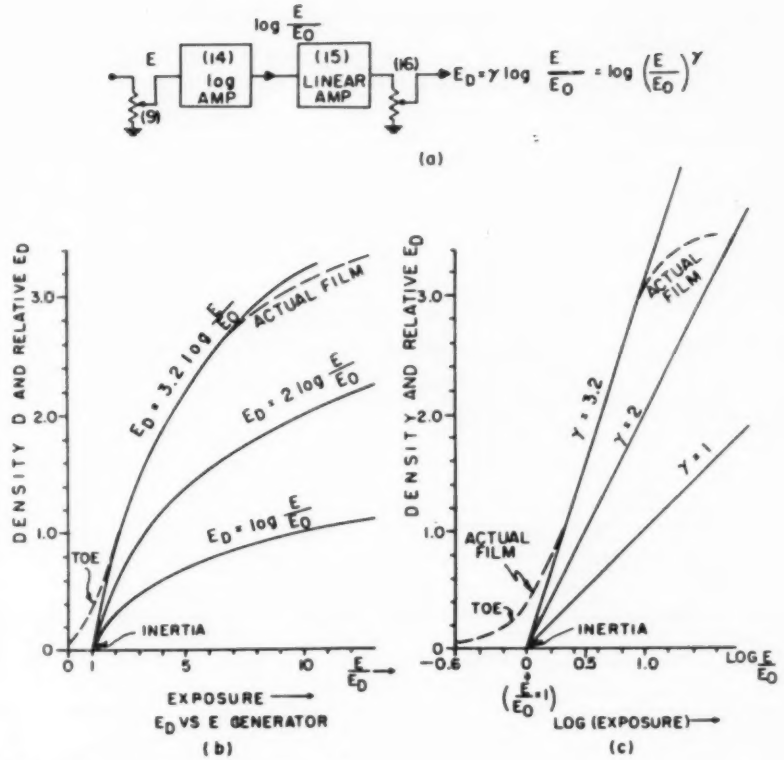


Fig. 6. Generation of D-E characteristic.

It is important to have available voltages which are proportional to the densities of the three dye layers. These voltages should be adjustable to simulate variations in such characteristics as the toe and gamma of the processed film. In addition, they permit a close approximation of the unwanted dye absorptions, mentioned above, by the intermixture of densities of each layer in proportions to produce a total density to each of the primary colors. Having obtained voltages which represent the total density to each color, these voltages must then be converted to a form suitable for driving the picture tube.

(*1*) *Generation of Voltages Which Are Proportional to the Densities of Individual Dye Layers.* For clearness the following exposition is divided into logical steps which may not reflect exactly the physical circuitry used. Referring to Fig. 6 the three exposure voltages (E_r, E_g and E_b) are impressed on separate nonlinear amplifiers whose transfer characteristics closely approximate the D-E curve of the positive stock as shown in Fig. 6(b). Simplifying the notation by dropping the subscripts from E_r, E_g, and E_b, because the exposition applies equally well to all three, the first unit (14) is a logarithmic amplifier whose input is exposure-voltage E and whose output is the voltage

$$E_D' = \log_{10}(E/E_0) \qquad (2)$$

Here E_0 corresponds to an exposure voltage near the "toe" of the D-E curve and is often called the "inertia" of the film; it is the value of E for which $\log_{10}(E/E_0) = 0$.

Block 15 represents an amplifier whose gain (γ) is adjusted by potentiometer (16). The voltage output of (16) is therefore

$$E_D = \gamma \log_{10}\frac{E}{E_0} = \log_{10}\left(\frac{E}{E_0}\right)^{\gamma} \qquad (3)$$

For values of E close to E_0 the output E_D of the amplifier is made to depart from a logarithmic law to simulate the region near and below the "toe" of the actual film characteristic (see Figs. 6(b) and 6(c)).

$E_D(r)$, for example, is a voltage proportional to the equivalent density of the red-sensitive layer of the positive film. γ (gamma) is the slope of the D-E curve when it is plotted against log (E/E_0). E_D is shown plotted against both E/E_0 and $\log_{10}(E/E_0)$ in Figs. 6(b) and (c). The maximum value of E_D represents a density in excess of 3.0.

Since $E_D(r)$ is a voltage which is a quantitative analog of the equivalent density of the red-sensitive (cyan) dye to red light, it can be added to voltages which are also quantitative analogs of the equivalent density of other layers to red to obtain total density to red.

(*2*) *Analog of Unwanted Spectral Absorption of the Dye Layers.* The cyan dye produces the desired controlling density

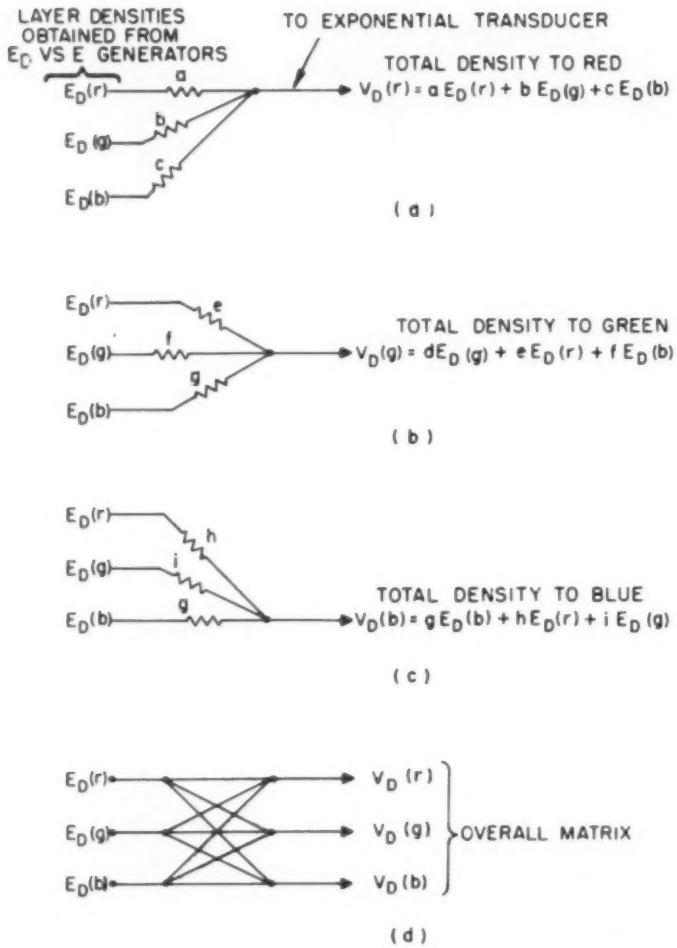


Fig. 7. Matrix to simulate unwanted dye absorption and to match dyes to phosphors.

to red light. In addition it produces unwanted densities to green and blue. Corresponding unwanted absorptions characterize the yellow and magenta dyes.

To match exactly the *spectral* characteristics of the light coming through the various dyes would require a large number of spectral primaries each controlled by a different gamma. However, only a *colorimetric* match is required and it appears that a satisfactory match can be obtained by three primaries produced by the phosphors of the picture tube and controlled through a dye density matrix and an exponential system.

The total density to red is simulated in the Analyzer by a voltage $V_D(r)$. It is obtained by adding to the red-density voltage $E_D(r)$ in the "cyan channel," density-voltages from the "yellow" and "magenta" channels which are proportioned according to their contributions to the unwanted densities. The same is done in the magenta and yellow channels.

The process is best described by reference to Fig. 7 which illustrates a matrix simulation of the unwanted dye absorptions. The proportions of the density voltages obtained from each channel are given by the coefficients of Eqs. (4a), (4b) and (4c). These coefficients are calculated from "dye-grid" diagrams

$$V_D(r) = a E_D(r) + b E_D(g) + c E_D(b) \quad (4a)$$

$$V_D(g) = d E_D(g) + e E_D(r) + f E_D(b) \quad (4b)$$

$$V_D(b) = g E_D(b) + h E_D(r) + i E_D(b) \quad (4c)$$

where $b, c;\ e, f;$ and h, i are the proportions of each dye-density voltage contributing to the unwanted absorption. To illustrate the degree of match obtainable, a dye grid for Type 5382 film and a grid obtainable by a selected matrix and a typical 21AXP22 color TV picture tube have been compared. While the match is not perfect, it appears satisfactory, and it should be noted that by proper selection of the matrix exact colorimetric match can be obtained on a chosen group of colors (which might advantageously include flesh color) (see Fig. 8).

(3) Analog of the Film Viewing System (Fig. 9). The positive film is normally placed in a projector which emits white light. The "transmission," T, of light in a primary color depends on the "density," D, to light of that color according to

$$D = \log_{10}(1/T) \quad (1)$$

or, conversely,

$$T = 10^{-D} \quad (1a)$$

The picture tube produces color from the individual excitation of red, green and blue phosphors geometrically arranged in a mosaic. The process is additive in that the excitation of a single phosphor produces a primary color of maximum saturation. Yellow is produced by the simultaneous excitation of the green and red phosphors. Other colors are produced in a similar manner. White is produced by the simultaneous excitation of all three primaries. Each phosphor acts independently of the other two.

Since the film is printed from a negative, the Color-Film Analyzer must reduce its transmission of light as the voltage analog of exposure increases.

The picture tube is normally biased so that it produces peak white (from the simultaneous excitation of its three phosphors). A voltage analogous to red exposure (E_r) causes a *reduction* in the amount of red light emitted. This leaves a preponderance of blue and green (i.e., cyan) light.

The voltage analogs of green and blue exposure similarly reduce the green and blue components of white light resulting in the emission of magenta and yellow light.

The unwanted reduction in green intensity, caused by red exposure, due to the unwanted dye absorption, is simulated by injecting a suitable magnitude of red signal in the green channel in the manner described above in Eq. (4b) and Fig. 7. The same applies to the other color channels.

The three voltage outputs of the matrix which represent total *density* to each primary must result in the "transmission," T, of the corresponding amount of light from the picture tube. Simplifying the notation by (a) neglecting the unwanted dye absorption and (b) dropping the color subscript designation, results in a transmission, T, which is equal to

$$T = 10^{-E_D} \quad (5)$$

The transmission of the picture tube is proportional approximately to the square of the input voltage, E_T, or

$$T = k E_T^2 \quad (6)$$

where k is the transmission per volt squared.

Combining Eqs. (5) and (6)

$$T = k\,E_T^{\,2} = 10^{-E_D}$$

or

$$E_T = \left(\frac{10^{-E_D}}{k}\right)^{1/2} = \frac{10^{-0.5\,E_D}}{k^{1/2}} \quad (7)$$

but

$$E_D = \gamma \log_{10}\left(\frac{E}{E_0}\right) \quad (3)$$

so that

$$E_T = \frac{10^{-0.5\gamma \log_{10}(E/E_0)}}{k^{1/2}} =$$

$$\frac{10^{\log_{10}(E_0/E)^{\gamma/2}}}{k^{1/2}} = \left(\frac{E_0^{\gamma/2}}{k^{1/2}}\right)E^{-\gamma/2} \quad (8)$$

When E_T is impressed on the picture tube it will produce a transmission according to Eq. (6), or

$$T = k\,E_T^{\,2} = E_0^{\gamma} \cdot E^{-\gamma} \quad (9)$$

Notice that the transmission, T, decreases as the exposure, E, increases. The same applies to all three primaries, i.e.

$$T_r = E_0^{\gamma} \cdot E_{(r)}^{-\gamma} \quad (9a)$$

$$T_g = E_0^{\gamma} \cdot E_{(g)}^{-\gamma} \quad (9b)$$

$$T_b = E_0^{\gamma} \cdot E_{(b)}^{-\gamma} \quad (9c)$$

Since $T \leqq 1$ for all values of E, Eq. (9) holds only for values of $E \geqq E_0$, that is for exposures higher than the value corresponding to the toe. The picture tube is biased to its maximum white transmission for $E = 0$. This value corresponds to the "fogging" level of the positive film. Exposure values from zero to a value slightly in excess of the inertia (E_0) cause the transmission to flare in smoothly from the fogging level to $T = (E/E_0)^{-\gamma}$ as shown plotted in log units in Fig. 9(b). Also shown is the excitation E_T of the picture tube for different values of exposure.

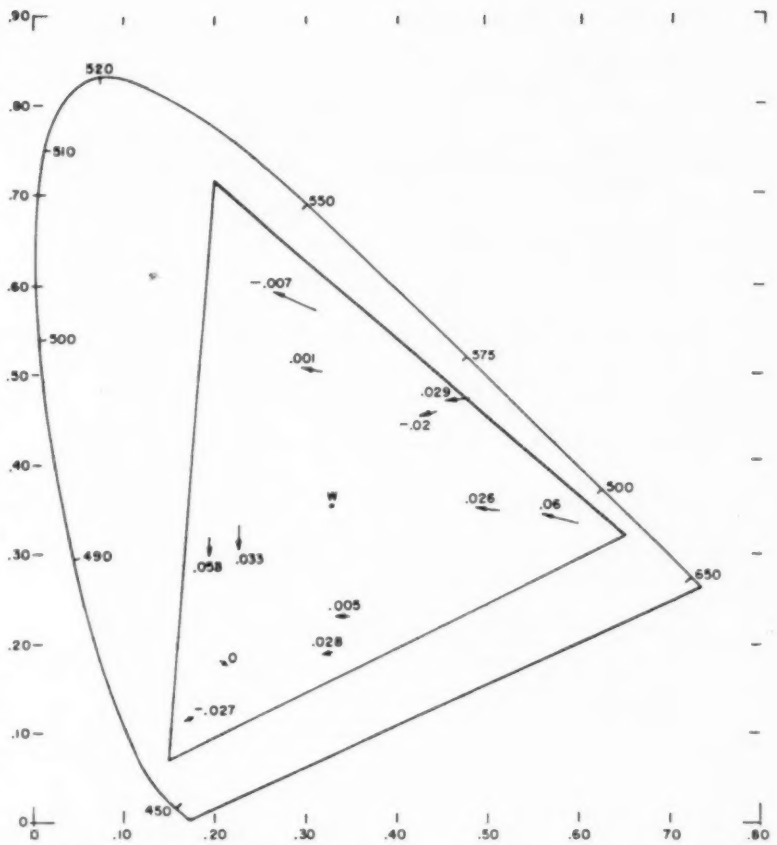


Fig. 8. Errors in color matching between positive color film and color film analyzer: arrow tail is at the desired chromaticity; arrow head is at the chromaticity reproduced by the analyzer; numbers next to arrow head indicate increase in visual density over desired value.

VI. General Requirements for Analog Operation

A. Analog of the Printer

(1) Contact Printing. The flying-spot method of exposure is open to limitations not present in contact printing. The flare in the optical system must be reduced to a minimum; otherwise the contrast and the simulated *D-E* characteristic may vary from scene to scene. Flare may result also from scanning with a large spot which will reduce resolution and also make gamma a function of the illumination.

Persistence of the phosphor illumination must also be minimized for the same reason.

(2) Taking Sensitivities. For an exact analog in the case of additive printing, each of the three equivalent taking responses of the electronic system should be the same as that of the corresponding emulsion sensitivity multiplied by the spectral distribution of the corresponding printing light component. For the electronic system this response involves the product of (a) the flying-spot scanner spectral output, (b) the dichroic mirror characteristic, (c) the filter characteristic and (d) the photomultiplier response.

Blue and green responses can be matched fairly easily but, if red is matched, the signal-to-noise ratio is poor due to negligible light output from the flying-spot scanner in the longer-wavelength red region. When working with a given negative stock the actual requirement is not a perfect curve match, but merely similar answers. The dye characteristic of the negative stock indicates that the red taking response can be lowered in wavelength substantially with only small increase in red exposure caused by green light, and experimental results indicate that adequate analog operation can be obtained with adequate signal-to-noise ratio by shifting the peak of the red taking response to a substantially shorter wavelength than that of the film response.

B. Transfer Characteristic

The overall transfer characteristic of the electronic system is controlled by the combination of the D vs. E nonlinear amplifier and the picture-tube nonlinearity. Since the dye matrix requires the addition of voltages which are analogs of the density of each layer, the D vs. E nonlinear amplifier should precede the matrix and is the logical place where the transfer characteristic can be adjusted to the desired value independently of other items. The dye matrix is then followed by an exponential transducer (amplifier plus tube) to convert voltages representative of density to light output.

The available contrast range in the display limits the range over which it is practicable to match accurately the D vs. E and the exponential functions. This range is limited to a density slightly in excess of 3.0. The D vs. E function is relatively simple to match for high-gamma (3 or 4) positive print stock since the required nonlinearity is not great. The greatest nonlinearity in the D vs. E function is the limiting action to simulate the toe or minimum-density region. For low gammas (near 1) the nonlinearity involved in the D vs. E function becomes very substantial. The exponential nonlinearity should be correct over the desired reproduction contrast range. The square (approximate) law which is

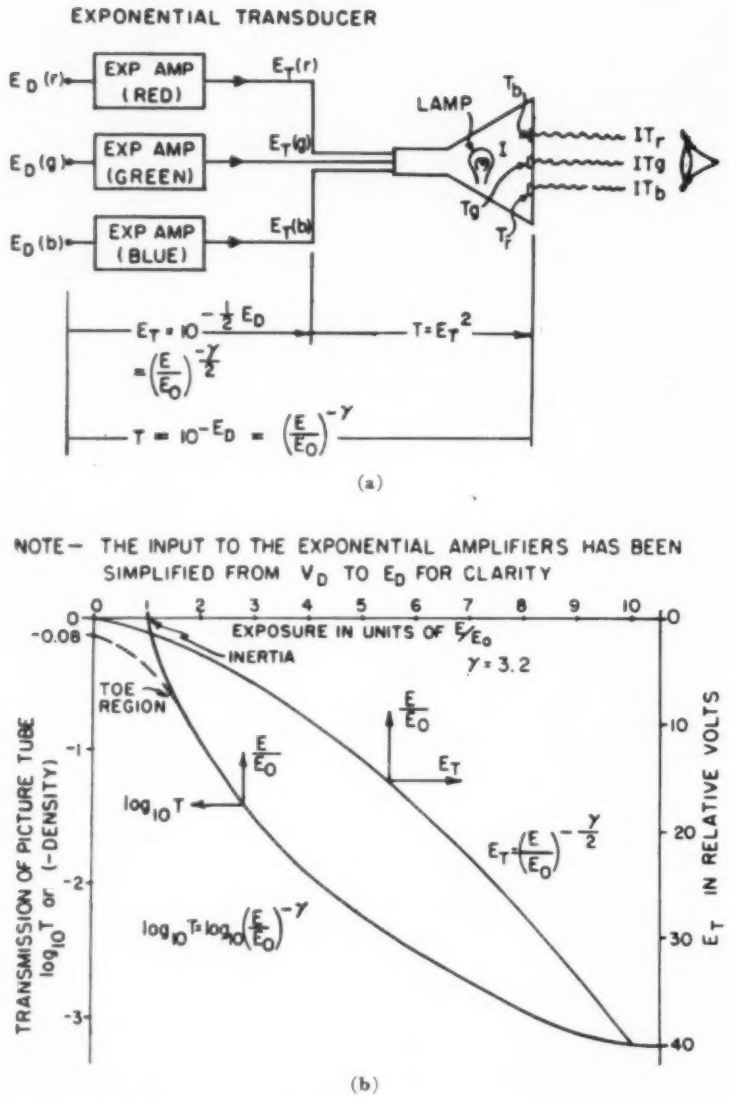


Fig. 9. Analog of projected positive.

characteristic of the picture tube helps, and about half of the nonlinearity of the exponential transducer comes from the picture tube and half from the "so-called" exponential amplifier.

VII. Stability and Reliability

Since it is desirable that the overall accuracy of the equipment be of the order of 1 printer step (0.025 or 0.03 in log E units), high stability and careful alignment are required. Both gains and nonlinear characteristics must remain fixed with time. To accomplish this, judicious use is made of feedback circuits.

The exposure analog system (particularly the photomultiplier) is susceptible to significant gain variations and is stabilized by a reference light pulse which by-passes the negative film by going through the sprocket holes. The amplitude of this pulse, measured at the top of the exposure adjustment potentiometers, is maintained constant by a feedback control system.

The nonlinear circuits are made independent of tube characteristics by the use of progressively biased diodes which switch impedance elements in and out of the circuit at different levels. The exponential function is further stabilized by designing the exponential nonlinear amplifier and the picture-tube nonlinearity to cooperate closely as a single nonlinearity. D-c restoration and clamping of special design are used to provide maximum stability in the overall operation. Reliability is obtained by operating tubes and components substantially below rating and by using "reliable" types of tubes.

VIII. Performance and Statistical Results

The ability of the color analyzer to display the same density and color balance as the final print was measured by quantitative comparisons between color negatives and the corresponding additively printed positives.

The equipment was calibrated in the manner described in Sec. V–B, above. Eastman color negatives were then inserted in the color film analyzer and the density and color balance of the positive picture displayed on the picture tube were adjusted to match those of corresponding Eastman positive prints projected optically. The printing instructions supplied by the analyzer were then compared with the printing data used in printing the positive.

A fairly experienced operator adjusted 34 scenes with the following standard deviations (σ):

Density adjusted to ± 0.029 log E
Red adjusted to ± 0.028 log E
Green adjusted to ± 0.028 log E
Blue adjusted to ± 0.033 log E

or approximately ± 0.030 log E for the four parameters.

This means that for these scenes the exposure will be correct for (red, green, blue and density) within

± 0.03 log E for 68.2% of the scenes
± 0.06 log E for 95.4% of the scenes

The comparison was somewhat quantized because the Eastman data were given in 0.025 steps while the Hazeltine Analyzer was calibrated in 0.030 steps. Thus three steps of Eastman data equal to $3 \times 0.025 = 0.075$ could only be approximately matched by two steps ($2 \times 0.03 = 0.06$) or three steps ($3 \times 0.03 = 0.09$). This discrepancy is of no consequence in the use of the device but explains the apparent quantization of the correlation data.

The actual distribution in color adjustment for four operators, ranging from no experience at all to fair experience, is shown in Fig. 10 for a total of 102 scenes.

The curves are plotted in terms of intervals centered on 0, ± 0.03, ± 0.06, ± 0.09 log E, each interval being equal to 0.02 log E in width. Note that:

(1) Red was adjusted to ± 0.01 log E, or better, for 45 scenes (44%)
Red was adjusted to ± 0.04 log E, or better, for 87 scenes (85%)
(2) Green was adjusted to ± 0.01 log E, or better, for 38 scenes (37%)
Green was adjusted to ± 0.04 log E, or better, for 89 scenes (87%)
(3) Blue was adjusted to ± 0.01 log E, or better, for 32 scenes (31%)
Blue was adjusted to ± 0.04 log E, or better, for 80 scenes (78%)

There has not been time, as of this date, to obtain quantitative correlation data for subtractive printers. However, comparison of films subtractively printed

from data supplied by the Hazeltine Analyzer shows a high order of correlation.

IX. Equipment Specifications

Image Characteristics

(a) Color TV image size: Approx. 12 × 16 in.
(b) Reference projector image size: Approx. 12 × 16 in.
(c) Normal viewing distance: Approx. 6 times picture height.
(d) Color gamut of TV image: Determined by primaries of shadowmask color TV tube.

Film and Transport Characteristics

(a) Film sizes: 35mm and 16mm.
(b) Reel capacity: Normally up to 2000 ft of negative.
(c) Transport mechanism: Standard high-grade hand-rewind set with positive interlock to protect negative.

Type Film

(a) Color negative to color positive: Equipment simulates Eastman Color Positive Print Film, Type 5382, when exposed to Eastman Color Negative Film, Type 5248 or other types of negative suitable for printing on Type 5382. Other positive film types can be simulated by modification of the equipment.
(b) Color positive to color positive: Kodachrome Commercial Color Film, Type 5268, to Eastman Reversal Color Print Film, Type 5269.
(c) Black-and-white negative to positive: Any positive stock processed to a gamma between 2.0 and 4.0.

Reference Films

Provision for insertion into both TV and projection systems of single-frame clips for reference and calibrating purposes.

Timing Controls

(a) Types of controls: Individual red, green, and blue intensity controls. Range in log E: ±0.75 in 0.025 steps (total of 1.5).
(b) Read-out
1. For additive printing: Red, green, and blue light intensities. Range in log E: ±0.75 in 0.025 steps (total range = 1.5 log E).
2. For subtractive printing: Cyan, yellow, and magenta color-compensating filters. Range in log E: 0 to 75 in steps of 0.025 log E. Printing light intensity: ±0.75 in 0.025 steps (total range = 1.5 log E).

Calibration Controls

(a) Standardizing controls: Vernier R, G and B printing-light intensity controls are provided to permit standardization of the printing controls of previewer on reference scenes.

Overall Size

Height, 4 ft, 9 in.; width, 4 ft, 8 in.; depth, with optical projector in operating position, 6 ft, 6 in.

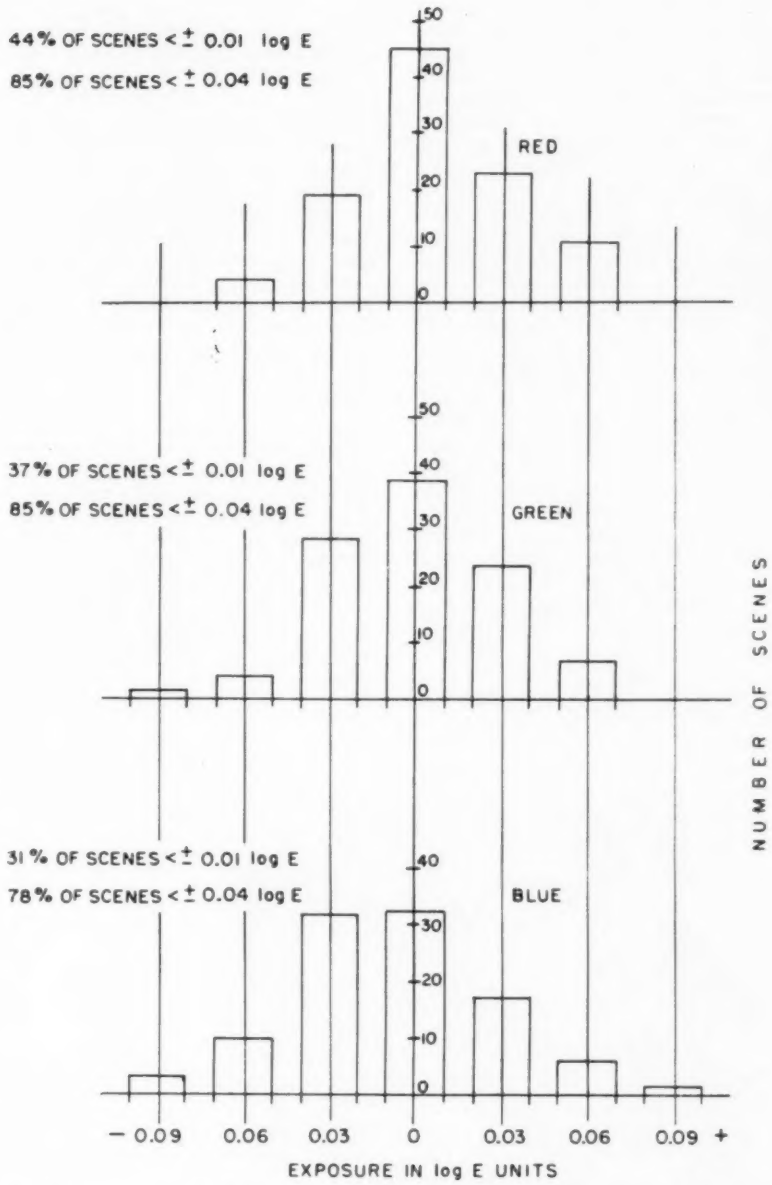


Fig. 10. Accuracy of color balance: error distribution curve in additive "timing" for four operators on 102 scenes.

Power

Approximately 3 kw at 110 or 220 v, 60 cps, a-c single phase.

X. Experience in the Use of the Color-Film Analyzer

The use of the Hazeltine Electronic Color-Film Analyzer by Pathé Laboratories has presented no real problems in timing color motion-picture film after the initial experimental period which, of course, can be expected with any new type of equipment. Since the experimental period, a number of reels of color film have been timed by people who, while experienced in the laboratory, had no previous experience with this equipment. Negative material used for these tests was selected only to the extent of including material requiring decided changes in color balance and exposure requirements from scene to scene.

It has been found that after timing only three or four reels and seeing the result of prints therefrom, any individual who can look at a color scene, and by turning dials make it appear on the tube face as he would wish it to appear on film, can satisfactorily time a motion-picture reel.

There are many advantages with this type of timer over other methods which have been previously used. The methods which require the making of one or two

frame prints of each scene at various color balances and exposure conditions, and then developing and examining these printed strips, not only require considerably more time, but also require an extremely experienced individual. In many cases when timing by this method, the printing requirements must be estimated, since it is obviously impossible to expose short pieces of film with every possible color balance and exposure. Unless one of these exposures appears to be exactly correct for the scene in question, the timer must estimate the change required to produce an ideal print. This requires a tremendous amount of training and experience and frequently results in a print, in the case of some types of unusual scenes, which requires a large amount of additional adjustment and the making of another print before the scene approaches the required balance.

There are other types of color film analyzers which measure a frame of each scene of negative and indicate the balance required to produce an average gray density. This type of analyzer is useful in the case of average scene negatives which, of course, are the easiest to time by any method, but it fails seriously in the case of unusual subject matter or lighting.

Another valuable use of the electronic color-film Analyzer is in timing scenes which have changing light and color values as in the case of photography from a moving conveyance or in panoramic scenes. It is a simple matter while timing such a scene with this equipment to analyze frames in several different locations in order to arrive at the best average timing.

It is, of course, necessary that the color-film Analyzer controls be matched with the color positive film raw stock characteristics and processing in current use. This is accomplished by the use of standard scene samples which are processed using each new batch of film under carefully controlled conditions. These prints and the standard negative from which they were made are then used to pre-set the analyzer controls so that the analyzer will match the film and process.

(After the Convention presentation of the paper, a short demonstration film was projected, showing first a print made at one exposure and color balance throughout the roll. This demonstrated the scene-to-scene variations existing in the negative. Immediately following this print, there was shown a first print which was made based on the exposure indicated by the electronic color film analyzer.)

Discussion

Malcolm G. Townsley (Bell & Howell Co.): In the case of the scenes which required additional correction, did they require quite a lot of correction? In other words, is it characteristic of the system that it under-corrects a little bit when extreme correction is required?

Mr. Miller: No, I don't think that is the case. These are scenes which maybe by their character, their type of color in the scene, would require a little more correction than you might consider they need when you see the picture on the tube. Some of the scenes which required the most correction came out very well. It's not a function of the amount of correction.

C. Henderson Beal (University of Miami): Are there any nonlinearities in the photoelectric pickup and does frequency response of the photocells affect this timing in any sense? What is the overall color response of these cells; are they a special type?

Mr. Page: In reply to your first question, the frequency response of the multiplier photocells used depends effectively on the value of the anode load which you use with the photocell and these are equalized by the usual flying-spot scanner techniques to provide us with a bandwidth which is actually somewhat in excess of 6 megacycles at that point. The photocells used are those commonly used in color flying-spot scanners; they are RCA type 5819 in the blue and RCA type 6217 in the green channel and the red channel. We have made the overall spectral taking sensitivity of the photocells, when looking at the spectral distribution of the light provided by the flying-spot tube and modified by the dichroic mirrors, to be as close as is practical to the taking sensitivity of the 5382 positive stock. This is difficult because the flying-spot scanner phosphor is the type which has a peak in the green and has gradually falling spectral output in the blue and red regions. As a result of this, we can match the green characteristic very closely and have good signal-to-noise ratio; we match the blue characteristic very closely also but at the cost of loss in signal-to-noise ratio. The red characteristic provides us with the most difficulty, and actually our peak response is not at as long a wavelength as the film response, which is in the neighborhood of 700 mμ. Consequently, we measure the cyan dye density in the negative at a different spectral point, resulting in a lower measured density. We apply first order correction by raising the effective gamma in the red measuring channel and this appears to work satisfactorily as evidenced by the correlation data.

An Electromechanical Light Valve for Motion-Picture Printers

By FRANK P. HERRNFELD

This paper describes a light valve which is actuated from a control tape without use of intervening relays. The average change in intensity will take 10 msec, or less than one sprocket hole, when printer is running at 90 ft/min. The total maximum change obtainable is three stops which may be divided into 32 or 64 equal logarithmic increments. Flatness of field is that of a projection-type system. Light intensity is limited only by the size of lamp used.

THE LIGHT VALVE and associated equipment were designed to make semi-automatic, continuous or step motion-picture printers fully automatic. The system consists of a control tape perforator to make the tape for transmitting the necessary printing information, a pickup unit operated by the interrupter of the printer, and the optical system, part of which is the light valve.

The perforator utilizes exposed and developed 35mm motion-picture film as control tape. Seven perforations are used to convey all necessary information to the pickup unit. Five perforations are used to operate the light valve, the sixth brings the control tape to its starting point and the seventh may be used for either starting or stopping the printer or to operate a fading device. Thirty-two printer "lite" combinations are obtained from the five perforations used in a geometric progression. The five perforations represent lite 1, 2, 4, 8 and 16, respectively.

The control tape perforator is shown in Fig. 1. The control tape is threaded from the front, under the sprocket, over a tension roller, under the perforating punches back over the same sprocket. The tension roller keeps a tight loop, ensuring proper placement of the control tape in respect to the perforations.

Figure 2 shows a control tape with starter mark. A single sprocket hole length of control tape is used for each scene.

The schematic diagram of the optical system is shown in Fig. 3. The condenser lenses focus the filament of the lamp at the light valve plane. The collimator will focus the mask image to infinity. The objective lens focuses an image of the mask on the film plane. The spherical mirror behind the lamp forms an image of the filament in the interstices between the coils of the filament. The relative aperture of the optical system has a value of $f/1.2$.

Presented on October 3, 1957, at the Society's Convention at Philadelphia by Frank P. Herrnfeld, Frank Herrnfeld Engineering Corp., Box 65, Culver City, Calif.
(This paper was received on October 2, 1957.)

The light valve consists of a butterfly mounted in a circular aperture. When fully open the light valve will reduce the total amount of light the system is capable of delivering by about two-thirds stop. When fully closed, the light is reduced to about 5% giving a useful ratio of over four stops. The butterfly is actuated through a cam mounted directly on the butterfly shaft. This cam is of such shape that a unit pull on its periphery will result in a given percentage change in light output.

The butterfly actuating mechanism consists principally of five solenoids, a power transmitting steel tape and the cam. The solenoids are mounted and adjusted to exert a pulling motion on the tape when energized. One end of the tape is secured to a calibrating screw used for zeroing the butterfly. The other end works against a spring used for the return of the butterfly upon release of the solenoids. The excursions of the five solenoids have been limited and adjusted to produce 1, 2, 4, 8 and 16 linear units of pull on the power transmitting tape. Each linear unit of pull, when transmitted through the cam, will rotate the butterfly to produce a change of one lite, equivalent to a change of 0.03 log E. The information obtainable from the control tape provides 32 lites or $3\frac{1}{4}$ stops.

The preparation of a control tape is very simple. Light values are taken from the lite cards prepared by the timer and

Fig. 1.
The perforator.

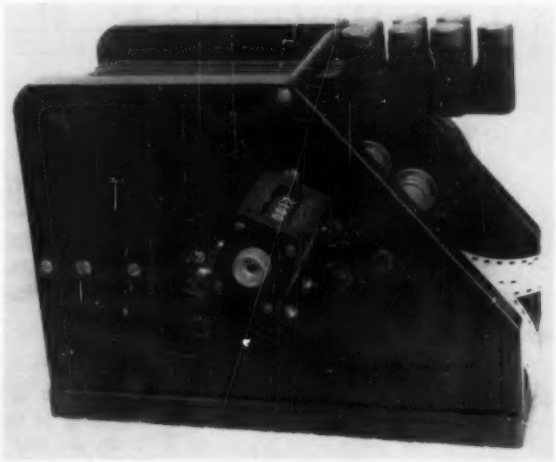
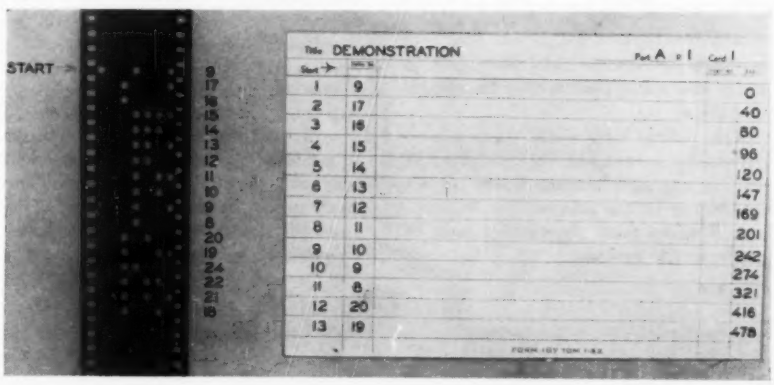


Fig. 2. Control tape and record form.



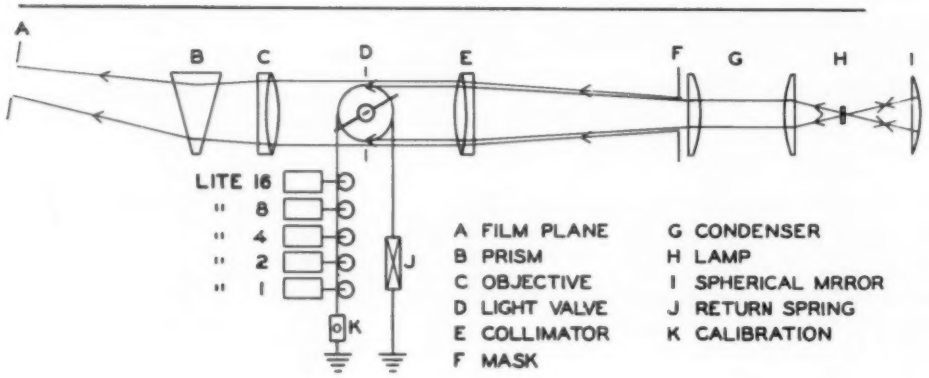
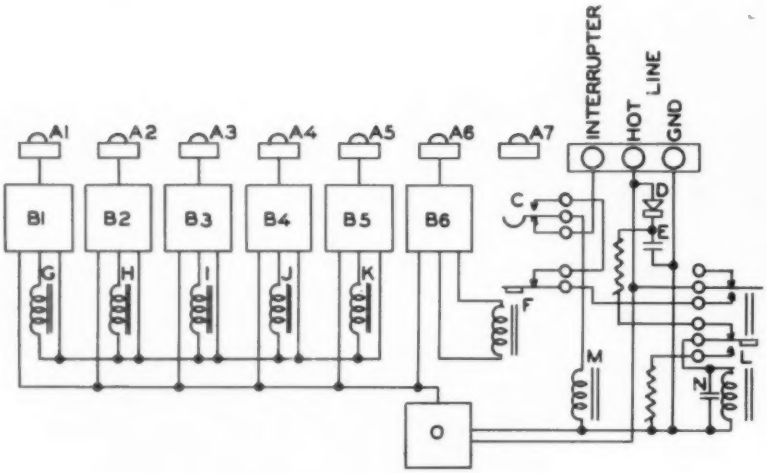


Fig. 3. Optical schematic.



A PHOTO TRANS. F TAPE RELAY K LITE 16 SOLENOID
B TRANS. AMPLIFIER G LITE 1 SOLENOID L TRANSPORT RELAY
C START SWITCH H " 2 " M ESCAPEMENT SOL.
D RECTIFIER I " 4 " N DELAY CONDENSER
E CONDENSER J " 8 " O POWER SUPPLY

Fig. 4. Simplified electronic schematic.

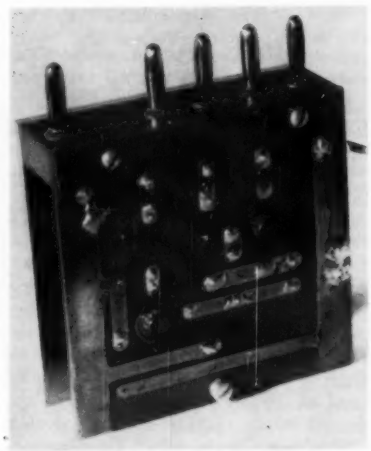


Fig. 5. Complete plug-in amplifier.

are encoded as fast as the keys of the perforator can be depressed. There is no limit to the number of scenes or length of control tape. To print on lite 9, it is necessary to punch lite 8 and lite 1; to print on lite 17, it is necessary to punch lite 16 and lite 1, etc. For loop printing the control tape may also be made into a loop, permitting continuous operation.

The pickup unit works on a power-driven, escapement-movement principle and is operated automatically by the interrupter on the printer. The information is taken from the control tape by photoelectric means.

Figure 4 is a simplified electrical schematic of the pickup unit, including amplifiers and solenoids operating the light valve. Each solenoid drive circuit consists of a photo transistor, an amplifier and a switching transistor. The reason for using transistors in this type of application is twofold: (1) speed of operation and (2) reliability.

Due to the low output impedance and high current-carrying capacity of a switching transistor, it was possible to reduce the inductance of the solenoids operating the light valve to about one-tenth over solenoids energized by thyratrons of equal power-carrying capacity. It was then possible to reduce the time constant of the electrical circuit to well below the time required to overcome the inertia of the light valve and associated equipment.

A current rise to 0.632 of its maximum value is attained in 1 msec. The time required to move a plunger of a solenoid over its maximum stroke is less than 8 msec. This short time-lag is obtained by using d-c in all parts of the system; therefore the system is ready to operate instantly on command and does not have to wait for an a-c voltage peak. The only moving parts are the butterfly and solenoids, resulting in low maintenance and freedom from the contact failures encountered with relay-operated devices.

Each complete amplifier is constructed as a compact plug-in unit (Fig. 5). All amplifiers are interchangeable.

When the negative film is properly notched, the complete light-change cycle will take place entirely in the projection aperture frame line when the printer is operating at 90 ft/min.

Glass Filters for Color Printing

By RICHARD L. WHITE
and ROBERT C. LOVICK

Tricolor filters are used to print Eastman Color Negative Film, Type 5248 onto Eastman Panchromatic Separation Film, Type 5235, and for printing these separations onto Eastman Color Internegative Film, Type 5245 and onto Eastman Color Intermediate Film, Type 5253. Such filters are also used in additive printers for making prints onto Eastman Color Print Film, Type 5382. The gelatin filters used for this purpose can be replaced with glass filters with a great increase in stability and a gain in exposure. All the glass filters recommended are standard, stock Corning glass filters with one exception. A unique red-absorbing filter, used in the green filter combination, has been made on special order by the Corning Glass Works and will be supplied by the Eastman Kodak Company.

The making of separation positives and internegatives from color negatives requires the use of special films, tricolor filters, and the use of step registration printers.[1] Such a system[2] is illustrated in Fig. 1. Eastman Color Internegative Film, Type 5245 and Eastman Panchromatic Separation Film, Type 5235 have been designed to be used in such a system. Eastman Color Intermediate Film, Type 5253 can also be used in this system.

Tricolor filters are also used in so-called additive printers[3] where the desired color quality of printing light is synthesized by the combination of correct proportions of red, green and blue light. One example of such a printing system is shown in Fig. 2.

Various combinations of Kodak Wratten Filters have been recommended to form the tricolor filters that are necessary to obtain the color separation of the three dyes of these systems. The purpose of this paper is to discuss these filters and systems and the advantages to be gained by using glass filters.

Desirable Filter Properties

There are three major criteria for choosing filters for additive printing and for the internegative duplication systems. The filters must satisfactorily separate the three color records and preserve such spectrally selective features as colored coupler masks; they must have sufficient transmission to permit the use of practical printing speeds; and they should have as good physical and optical stability as possible.

Several techniques may be used to evaluate the color reproduction properties of filters. First, of course, pictures can be compared. Secondly, spectrophotometric curves of the filters can be compared to the spectral sensitivities of the films to be used and to the spectral densities of the dyes of the negative. A third check that can be used is to produce cyan, yellow and magenta step tablets on the color negative film by narrowband exposures and to examine the sensitometric results of printing these tablets on an additive printer or through all of the steps of the internegative duplication system. In this way, the effects of various filters on the color reproduction of the system can be sorted out more easily.

The second desired property of filters for printing is sufficient transmission for practical printing speeds. Kodak Wratten gelatin filters are recommended for printing separation positives and internegatives and for additive printing. These filters are relatively dense and require high light intensities to obtain practical printing speeds. The transmission could be increased by using filters that have a broader passband, but this would be only a partial solution. If the passbands are broadened too much, the color reproduction of the system becomes unsatisfactory. There are Corning glass filters that have nearly the same passband as the Wratten filters but have higher transmissions. The spectral density curves of the gelatin filters and the glass filters suitable for printing separation positives and inter-

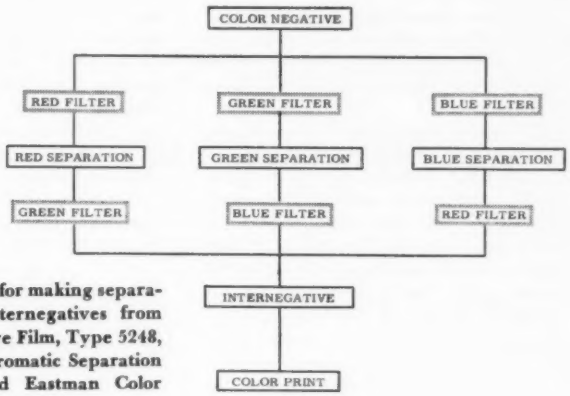


Fig. 1. Printing system for making separation positives and internegatives from Eastman Color Negative Film, Type 5248, using Eastman Panchromatic Separation Film, Type 5235 and Eastman Color Internegative Film, Type 5245.

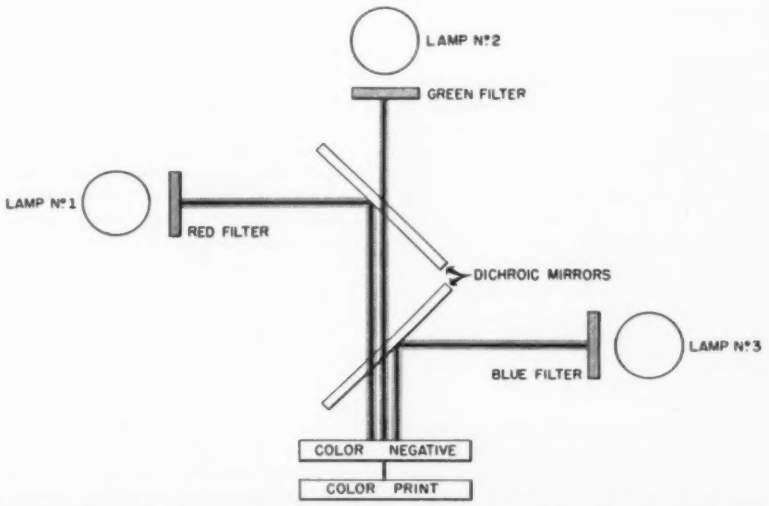


Fig. 2. Schematic diagram of an additive printing system using the Fish-Schurman optical system.

Presented on October 4, 1957, at the Society's Convention at Philadelphia by Richard L. White (who read the paper) and Robert C. Lovick, Color Technology Div., Eastman Kodak Co., Rochester 4, N.Y.
(This paper was received on October 29, 1957.)

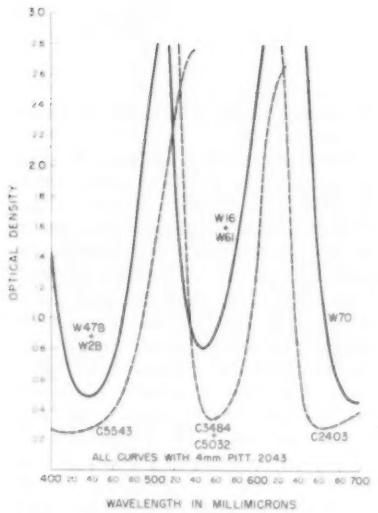


Fig. 3. Spectral density curves of filters suitable for printing Eastman Color Negative Film, Type 5248 onto Eastman Panchromatic Separation Film, Type 5235.

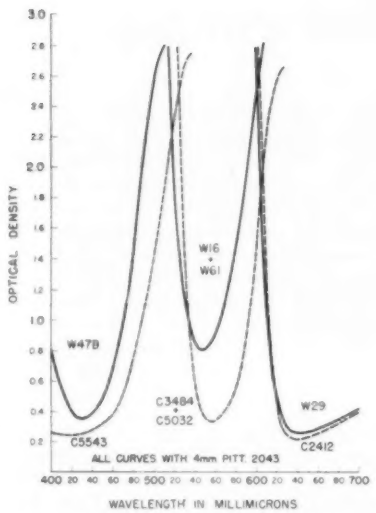


Fig. 4. Spectral density curves of filters suitable for printing separation positives onto Eastman Color Internegative Film, Type 5245 and Eastman Color Intermediate Film, Type 5253.

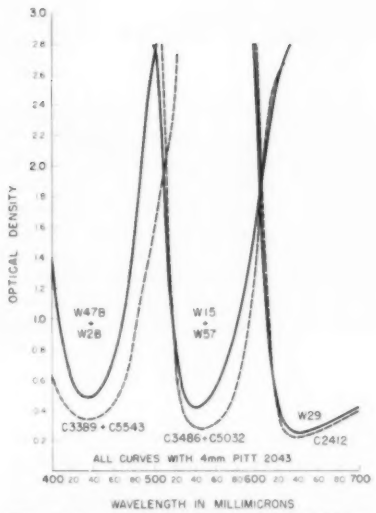


Fig. 5. Spectral density curves of filters suitable for use in an additive printer.

negatives are shown in Figs. 3 and 4. The same glass filters may be used satisfactorily in additive release printers (Fig. 5). The gain in exposure is not as large but the increased stability is more important.

In addition to increased transmission, glass filters also fulfill the third criterion for choosing printing filters — good physical and optical stability. The optical stability of the recommended gelatin filters is fairly satisfactory but they become faded and physically distorted fairly rapidly from the radiant energy of the printer light source under normal printing conditions. The stability of the glass filters has been found to be satisfactory over a wide temperature range and for long periods of time. Glass interference filters of various kinds were also investigated but found to be unstable to the radiant energy of the printer light, undergoing a change that is permanent, making the filters unusable. Figures 6 and 7 show the spectral shifts at high temperatures of gelatin and glass filters, respectively. The shifts are similar for each. However, the gelatin filters recover slowly and some of them do not recover at all. The physical stability of the gelatin filters cannot easily be shown on a graph but it is of major importance in their use. The glass filters recover much more rapidly and show no permanent physical or optical effects.

Choice of Filters

Filter combinations for blue exposure are generally limited in the amount of useful light they will transmit, since most blue filters have high minimum densities even at the point of their peak transmission. In addition, the complications resulting from the integral masks of the negative and emulsion sensitivities are greatest in the blue end of the spectrum.

The recommended blue filters for printing separation positives are the Wratten 47B+2B, and for internegatives the Wratten 47B. The 47B+2B combination is also recommended for additive printing. Stock thicknesses of the Corning 5433, 5543, 5550, and 5551 filters were investigated as substitutes for the 47B. Of these, the Corning 5543 appears to be the most satisfactory. The Wratten 2B is frequently replaced with the Corning 3389.

Although an ultraviolet-absorbing filter is desirable in release printing, the sensitivities of the Internegative Film, Type 5245, and the Intermediate Film, Type 5253, are such that an ultraviolet filter is not recommended, and its use will cause an unnecessary loss of printing light. The change to the broader cut of the Corning 5543 also makes the elimination of the ultraviolet filter possible for printing blue separation positives.

Filter combinations for green exposure present problems similar to those associated with the blue filters in terms of adequate transmission. There are some green filters having higher transmission than those recommended, but most of these are generally too unstable to be really useful.

The recommended green printing filter combinations are the Wratten 16+61 for separation positives and internegatives, and the Wratten 15+57 for additive printing. Several glass filters are available for replacing the Wratten 15 and 16. Of these, the Corning 3484 is the most suitable replacement for printing separation positives and internegatives. This filter is also suitable for additive printing, but the Corning 3486 with more blue transmission is satisfactory and will provide more light.

Substitutes for the Wratten 61 and Wratten 57 are not so easily found. There are no other Wratten or Corning filters that have the proper spectral cut. Interference filters for this purpose can be obtained but these have too little transmission or are too unstable, although some may be better than gelatin filters. In other work, however, we have used an experimental glass filter that suits this requirement perfectly. It has a sharp cutoff at about 600 mμ and is open toward the short wavelength region (Fig. 8). It also has very high transmission and is very stable. This filter is unique in these properties and we know of no other filter that approaches it. It will temporarily be called Corning 5032. A heat-absorbing filter should always be used between it and the light source; otherwise, it will absorb too much heat and break. A stock of this glass has been made on special order by the Corning Glass Company for the Eastman Kodak Company. The combination of Corning 3486 or 3484 + Corning 5032 makes a very stable green filter with high transmission.

Red-transmitting filters do not present much of a problem. There is a fairly complete series of Corning filters in this spectral region. A Wratten 70 is recommended for making red separations, and a Corning 2403 can be substituted satisfactorily. The Corning 2403 has its cutoff about 20 mμ further toward the green, and it has a much sharper cut and lower minimum density. A substantial increase in transmission is obtained with no sacrifice of color reproduction. A Wratten 29 is recommended for use in additive release printing and internegative printing and is a fairly efficient filter. A Corning 2412

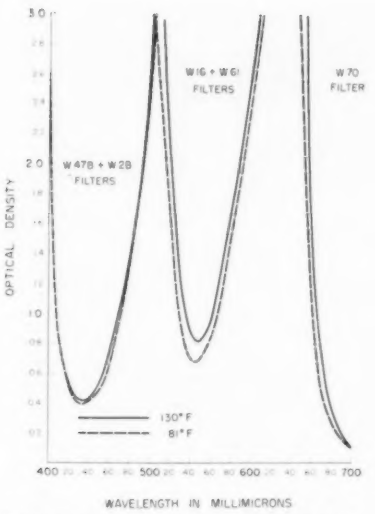


Fig. 6. Spectral density curves showing changes in Wratten gelatin filters with increased temperature.

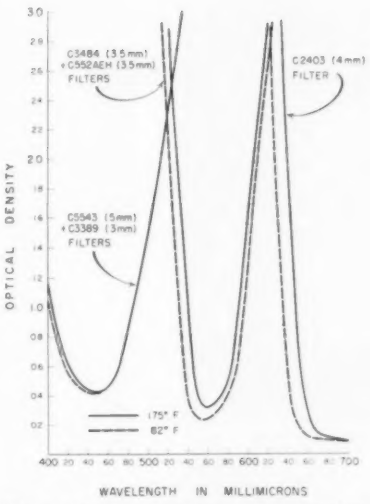


Fig. 7. Spectral density curves showing changes in Corning glass filters with increased temperature.

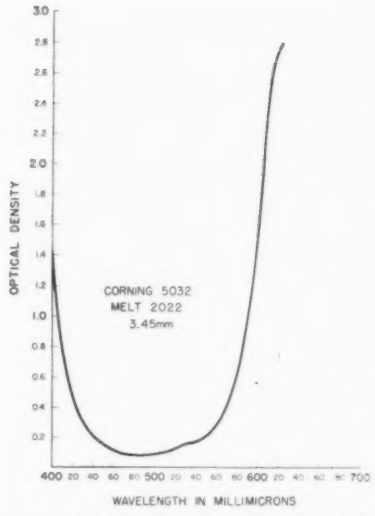


Fig. 8. Spectral density curve of experimental red-absorbing filter.

is essentially interchangeable with the Wratten 29.

Conclusions

The Corning glass filter combinations that have been discussed can be substituted directly for the corresponding Wratten filter combinations with no changes other than for the increased exposure that the glass filters give. Processing of separation positives and internegatives remains the same.

All of the Corning filters used were stock thicknesses. The experimental filter used was 3.5 mm thick.

The substitution of glass filters for gelatin filters will provide a considerable increase in light for the printing of separations and internegatives. Additive release printers could also gain in available light if a similar substitution were made. In addition, the glass filters will last almost indefinitely and will withstand much higher printing intensities than will any gelatin filter.

Table I is a summary of the filter recommendations for the uses discussed.

Table I. Filter Recommendations.

	R	G	B
Separation Positives			
Wratten	W70	W16 + W61	W47B + W2B
Corning	C2403	C3484 + C5032	C5543
Internegatives (Type 5245)			
Wratten	W29	W16 + W61	W47B
Corning	C2412	C3484 + C5032	C5543
Internegatives (Type 5253)			
Wratten	W29	W16 + W61	W47B
Corning	C2412	C3484 + C5032	C5543
Additive Printing			
Wratten	W29	W15 + W57	W47B + W2B
Corning	C2412	C3486 + C5032	C5543 + C3389

The tolerances on stock thicknesses of these Corning glass filters are sufficiently restrictive to make them satisfactory for these uses.

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2. C. R. Anderson, N. H. Groet, C. A. Horton and D. M. Zwick, "An intermediate positive-internegative system for color motion-picture photography," *Jour. SMPTE, 60:* 217–225, Mar. 1953.
3. W. T. Hanson, Jr., and W. I. Kisner, "Improved color films for color motion-picture production," *Jour. SMPTE, 61:* 667–701, Dec. 1953.

Recording Lip-Synchronized Sound Using a 16mm Magnetic-Optical Sound Projector

By LEE T. ASKREN
and RAYMOND J. DWYER

Professionally, sound motion pictures traditionally are made by the double system, affording flexibility in shooting, processing and editing. The methods described now open to the semiprofessional and to the amateur simple means to accomplish lip-sync 16mm sound using standard available cameras and the Kodak Pageant Magnetic-Optical Sound Projector.

THE MOST WIDELY USED method of professional sound motion-picture production is the double system, a term which denotes the use of separate devices for picture and sound operated in synchronism throughout the "take." The interlock can be electrical, using Selsyn motors or line-synchronous motor drive of the camera and the recorder, or it can be mechanical. The Cine-Kodak K-100 Camera (Fig. 1) is one of several standard 16mm cameras which can be fitted with a synchronous motor drive attachment. "Sync" marks are required, appearing on the picture film as visual indication of the start of the take when the two devices are in step and as a visible or audio signal on the sound film. The sync marks are usually obtained by the use of clapsticks attached to a slate which carries the scene number, the take number and other information essential to later editing. After the camera and the recorder are started and sufficient time has been allowed for them to get up to speed, the clapsticks are brought together; the camera picks up the clapsticks and the scene slate and the microphone on the set carries the sound of the contact of the clapsticks to the recorder.

The double system allows maximum freedom in the editing of picture and sound films and permits intercutting of shots of different coverage or angles of the scene, inserts, etc. After editing the picture and sound takes the final projection print is obtained by re-recording from the master sound film to a photographic soundtrack for a combined printing with the picture film or, in the case of a print which is to have a magnetic track, the sound is re-recorded onto the picture film, original, duplicate, or print, which has a magnetic stripe.

A 16mm magnetic recording and playback projector can be used as the sound recording element in double system production employing magnetic-striped film or fully coated 16mm single-perforated film. Simple methods for controlling the unit, so that it conforms to the requirements of the complete system, are presented, using the Kodak Pageant Magnetic-Optical Sound Projector.

The projector is driven by a split-phase 60-cycle a-c motor through a belt. As the motor is of more than ample power to drive the mechanism and the lamphouse blower its speed regulation is very good. However, frame-by-frame "in-step" operation of the projector with a motion-picture camera, operating at an exact speed, requires more precise control of the projector than is possible with the split-phase motor. A simple control is an 1800-rpm 60-cycle synchronous motor coupled to the shutter or driveshaft of the projector by a "timing" belt and toothed pulleys (Fig. 2) on the motor and projector shafts. The motor can be mounted on a subbase large enough to accommodate one projector (Fig. 3), or two projectors if desired. The weight of the projector is sufficient to keep it in place and provide the required tension on the timing belt. Since the speed of the motor shaft is 1800 rpm and that of the projector shutter shaft at sound speed is 1440 rpm the ratio of 12 teeth on the motor pulley and 15 teeth on the projector pulley provides exact control of the projector at sound speed, 24-frames/sec. Because the 1800-rpm motor is a control device only and the regular projector motor drives the mechanism, the control motor can be a small one. A $\frac{1}{75}$-hp motor is suitable for this purpose.

The use of an 1800-rpm synchronous motor to control the speed of the Pageant Projector requires no modification of the internal mechanism of the projector. The only changes necessary are the removal of the trial thread knob at the front of the projector, the addition of the toothed pulley to the shutter shaft extension and the gearing to the projector

Presented on April 30, 1957, at the Society's Convention at Washington, D.C., as a 16mm Kodachrome film with magnetic sound, the film having been produced using the equipment and attachments described in the paper. The authors are members of the Apparatus and Optical Div., Eastman Kodak Co., 400 Plymouth Ave. N., Rochester 4, N.Y.
(This paper was received on November 25, 1957.)



Fig. 1. Cine-Kodak K-100 Camera with synchronous electric motor drive.

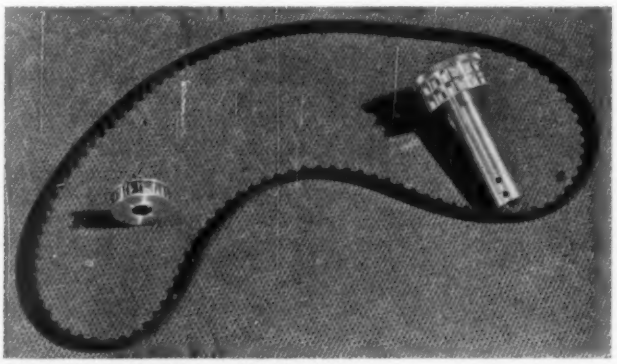


Fig. 2. Toothed pulleys and timing belt.

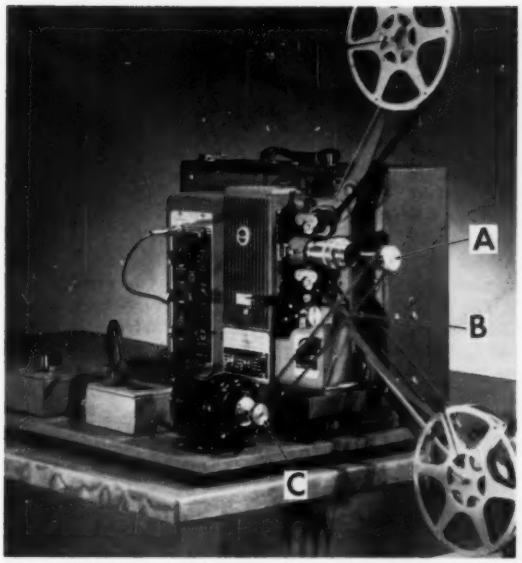


Fig. 3. Projector with external synchronous motor for speed control: A, toothed pulley; B, timing belt; C, toothed pulley.

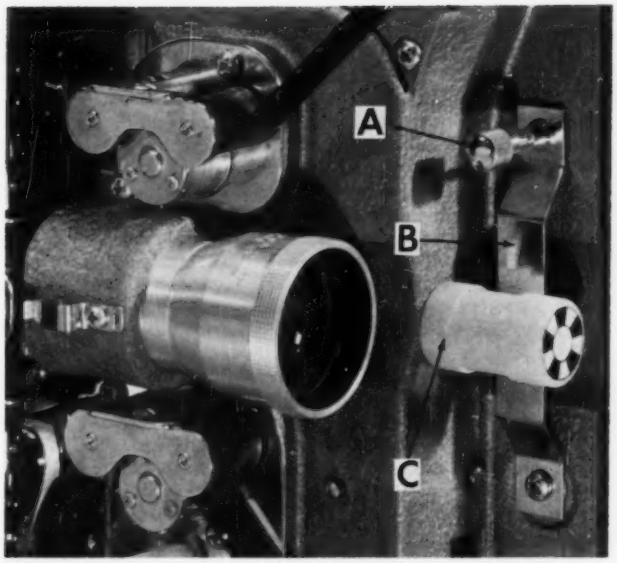


Fig. 4. Projector with mechanical brake for speed control: A, adjusting screw; B, brake shoe; C, nylon spool.

by a timing belt and a line-synchronous motor, also with toothed pulley. In operation, a single switch arrangement can be used to turn on the projector and the control motors simultaneously. If separate switches are used, the projector motor should be turned on first and then the control motor.

Another method of speed control of the Pageant Projector, when used as a recorder for double system sound, is by a mechanical brake. The thread knob is removed and replaced with a nylon friction spool and a spring steel shoe with a knob and screw to adjust the pressure of the shoe on the spool. The brake shoe is attached to the mechanism using the mounting screw holding the flange bracket of the mechanism to the case (Fig. 4). A stroboscopic disk having five light and five dark segments, illuminated by a neon lamp, a fluorescent lamp, or ordinary 15- or 25-w tungsten lamp, operating on 60-cycle current, comprises the visual means for establishing the 1440 rpm of the shaft and maintaining the setting as needed by adjustment of the screw.

This setup of friction brake control of speed to maintain "in-step" operation with a camera or cameras requires that the normal projection speed of the projector be above that of the camera(s), to permit more or less slowing down as needed to lock in the recorder with the camera or cameras. This additional speed of a fraction of a frame per second has been provided in the Pageant Magnetic-Optical Sound Projector. The friction brake method of control can also be used to maintain the speed of the projector at silent rate if desired or at 1000 frames/min as in time-and-motion study analysis.

Having completed the picture film in "exact-speed" camera(s) and the magnetic sound record in the synchronized projector, the step following the processing of the picture film(s) is the editing of the related films following the usual methods of professional production with rewinds and synchronizers; or, lacking these, a pair of projectors will serve the purpose.

There are several methods of finding the sync signal on the magnetic soundtrack. One way is to thread the sound take in the projector and operate the mechanism at silent speed, listening for the sound of the clapsticks. The projector is stopped when the sound is heard and reversed to carry the film back to a point ahead of the sync sound mark. The volume control is turned up and the mechanism shutter shaft extension is rotated manually until the beginning of the synchronizing signal is heard. By turning the knob slowly, first in one direction and then in the other, the start of the



Fig. 5. Locating synchronous signal with sync finder: A, sync finder.

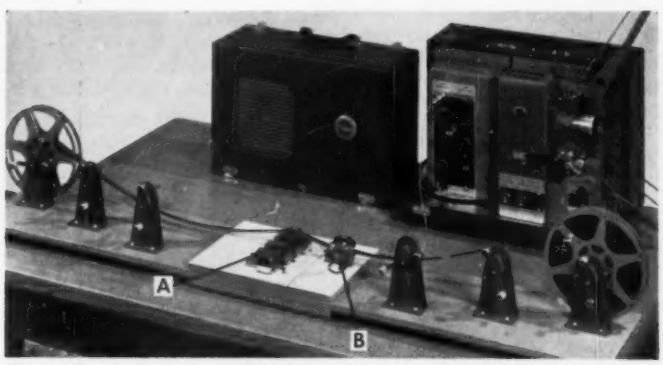


Fig. 6. Rewinds and synchronizer with tape recorder head as sound reader. Magnetic head is connected to microphone input of standard projector: A, synchronizer; B, sound reader.

sound of the clapsticks can be determined accurately. The sound film is marked at this point.

Another method utilizes a magnetic record-playback head, of the tape-recorder type, mounted in a handle or base. The head should be of high impedance; it is connected to the microphone input of the amplifier. The magnetic sound film take is placed on a rewind and the film is wound from one reel to the other, the sync finder locating the clapstick sound. When the "start" signal is located the film can be kept stationary and the sync finder moved back and forth to determine exactly where the signal begins (Fig. 5). The sound film is then marked at this point.

Still another way of finding the sync signal is to use a magnetic record-playback head, of the tape-recorder type, in conjunction with a ganged-sprocket synchronizer with the sync finder mounted on the same board (Fig. 6).

As mentioned before, shots of different coverage or angles of the scene or insert footage can be intercut as required by the script, and the separate soundtrack film correspondingly edited as needed. The next step is to re-record from the edited magnetic soundtrack to the picture print which has been magnetically striped. Figure 7 shows a simple means of mechanical interlock of two Pageant Magnetic-Optical Sound Projectors which requires no modification of the mechanisms. The only adjustments required are the installation of toothed pulleys on the shutter shaft extensions and the use of a timing belt. The two projectors are placed side by side with the timing belt running from one pulley to the other. The projector motor switches are turned on simultaneously or both projectors can be plugged into a common outlet hooked up to a single control switch so that turning on the switch starts both projectors. The mechanical interlock system is superior to the method of using two line-synchronous machines because it eliminates any problem resulting from starting time variations.

The preliminary stage of re-recording from the edited magnetic soundtrack to the striped picture print is to run the two films "in-step" (Fig. 7), first threading the films in the projectors so that sync marks are at the proper locating points in the machines. This double system playback arrangement provides for checking picture with sound, script notations for addition of narration or musical background, trial adjustment of recording level, etc. The projectors can be reversed and still remain "in-step." The amplifier output from the projector used for playback of the magnetic soundtrack is fed to the "phono" input of the other projector which is threaded with the striped picture film and, therefore, functions now as the recorder. The setup provides two microphone inputs and one phono input if signal sources in addition to the magnetically recorded master soundtrack are to be mixed.

The procedure after determining the changes to be made to the sound record is that of running the two projectors "in-step" as maintained by the toothed pulleys and the timing belt, the end result being a picture print with magnetic soundtrack. If additional prints are required, a simple method is that of using the first print as the master and re-recording from it to additional prints as needed; the first print has finished sound and using it as the master avoids the work of adding narration, music, effects, etc., each time a duplicate print is made.

The methods of making 16mm magnetic lip-synchronized sound motion pictures described here should benefit industrial organizations, groups, and even individuals who want to produce sound movies, for a variety of purposes, but have not possessed suitable equipment. The projector used is standard and readily available. Since the synchronous control method involves no modification of the projector mechanism, there is no need for the projector to be returned to the factory or to a service shop for the addition of the motor and the toothed pulleys. If the user wishes to control the speed of the projector by the mechanical brake method, the addition of the necessary parts is a simple matter.

Acknowledgments

The authors wish to acknowledge the major contributions of their associates, Howard Fairbanks, Richard C. Gearhart, Robert C. McClelland, Paul Macomber, William S. Mittelstadt, Fred O'Brien, John A. Rodgers, Frank Ross and others in the preparation of this paper and the development and testing of the methods and devices described.

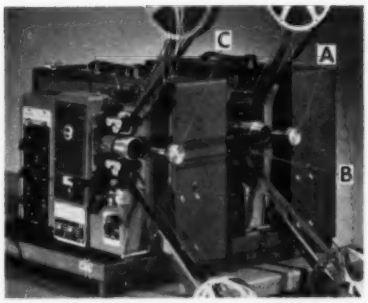


Fig. 7. Projectors with mechanical interlock using timing belt: A, toothed pulley; B, timing belt; C, toothed pulley.

Discussion

George Lewin (Army Pictorial Center): In the second system of synchronism that you showed, is the inference that when you slow the projector down by means of the stroboscopic disk it's going to stay in sync for a reasonably long take?

Mr. Askren: It will require manual adjustment throughout the take; however, if you watch it and adjust it every 15 or 30 sec, you can keep within a fifth of a frame or less, perhaps, if you try to.

Mr. Lewin: But your only reason for advocating that is that it's a little bit simpler?

Mr. Askren: It's very simple, yes. That's one justification for it. The brake can also be used to maintain synchronism between the projector and a tape recorder when transferring sound from the tape recorder to the projector, where small amounts of correction are required for differences in creep or motor speeds from one time to another.

Stuart E. Bonwit (Johns Hopkins University): Would you care to comment on the attachment to the camera?

Mr. Askren: The attachment for the camera is a device which in this particular instance was furnished by Camera Equipment Co., but there are other suppliers of such devices too. It consists of an 1800-rpm synchronous motor which is connected to the line in the usual way. In both types of recording, incidentally, the color shots were made with the synchronous motor drive on the projector and the black-and-white shots were made with the mechanical brake arrangement with the manual adjuster. In both cases the synchronous motor was used on the camera.

Thomas McMaster (Edward Bok Vocational School): Can you say just a word more about the reader you had attached to the microphone input of the amplifier?

Mr. Askren: Yes, the reader, or "sync finder" as we referred to it, is a tape-recorder type of magnetic record-playback head mounted on a piece of $\frac{5}{16}$-in. brass tubing, about 6 in. long, to serve as the handle. A shielded conductor about $2\frac{1}{2}$ ft long terminating in a screw-on type of microphone connector completes the device.

Ultra-Cold Weather Photography

By RICHARD R. CONGER

The U.S. Navy's expeditions to Antarctica as well as its Arctic operations over the past several decades have cast a new light on cameras, techniques and "winterization" of equipment. This paper discusses the Navy's use of still and motion-picture cameras in cold weather and their application on Operation DEEPFREEZE.

Like underwater photography, ultra-cold weather photography is a relatively new field and actual reports on the subject are either out-dated or nonexistent. Early still and motion-picture cameramen encountered untold difficulties that increased as the temperatures decreased. Even today, authoritative publications on this subject have either been disproven or modified during the Navy's Antarctic Expeditions, yet they are still being disseminated as the "doctrine of cold weather photography." For the purpose of this paper, ultra-cold weather photography is considered to include temperatures from −35F to −100F and below.

Even though kerosene has abrasive qualities, the nation's leading motion-picture handbooks advocate its use as a lubricant in cold weather. Early Alaskan cameramen delubricated their equipment and the cameras were run "dry" for cold-weather operation. The handbooks usually recommend that the lenses be removed and the cameras run immersed in kerosene for about one-half hour to keep them in "good condition."

Normal camera speeds are usually not high enough to cause undue friction without lubricants at the main points of actual wear, for the short runs generally made in very cold weather. This brought about the belief that the delicate tolerances would "take care of themselves" in low temperatures. In recent years, however, manufacturers, engineers and camera repairmen have recommended actual adjustments of the bearing clearances to counteract the stresses normally caused by the differential thermal expansion and contraction of the various metals used in camera construction. New products such as Teflon and nylon have added different aspects to specialized gear construction.

New delubricants like the "gunk"-type solution are also available, so that it is not necessary to use carbon tetrachloride, which pulls the oil even out of the very pores of the metals, leaving the gear or bearing like a degreased frying pan.

Presented on May 3, 1957, at the Society's Convention at Washington, D.C., by Warrant Photographer Richard R. Conger, U.S. Navy, Asst. Staff Photo. Officer, U.S. Naval Support Force — Antarctica, Bldg. D, Rm. 220, 6th & Independence Ave., S.W., Washington 25, D.C. (This paper was received on May 1, 1957.)

There are several schools of thought on the preparation of cameras for extreme cold weather, which run about as follows:

(a) Completely delubricate the camera mechanisms with carbon tetrachloride even to the grease in the individual bearings. Soak all the parts in a pan of light oil, such as sperm oil, and let the pieces drain on blotting paper. Reassemble the camera and run "as is."

(b) Completely delubricate the camera mechanisms with a "gunk"-type solution, even to the individual bearings. Finger or brush a very light coating of sperm oil, Mitchell oil or the lightest Navy standard low-temperature oil on the bearings, shafts and cams. Apply extremely light dabs of a slightly heavier low-temperature oil or grease to the gear-bearing surfaces. At a slow speed in a warm temperature, run the camera so that the grease and oil are spread evenly over the surfaces; then, do not use the camera



Fig. 1. Winterized and electrically heated Bell & Howell 70KM 16mm motion-picture camera with anamorphic lens, in use by W. W. Bristol, PHC, at a temperature of −35F at the world's Geographic South Pole. The fabric jacket aids the camera heaters. (U.S. Navy Photo)



Fig. 2. The author setting lens diaphragm on Kodak Cine Special II Camera. Ice axe with welded-on tripod screw becomes a lightweight unipod for trail work. (U.S. Navy Photo)



Fig. 3. Silver-cell battery vest, modified for Yardney LR-5 batteries. This power supply was used with success on all motor-drive cameras. (U.S. Navy Photo)

until the actual cold weather is encountered.

(c) Have the manufacturer readjust the critical tolerances for the temperature expected, to compensate for the coefficient of expansion of the different metals. Delubricate with a "gunk"-type degreaser and relubricate with low-temperature products which are available on special order from most large petroleum corporations.

(d) Completely delubricate the camera, and relubricate, using the silicone-type products now available.

(e) Determine a desired temperature level for the inside of the camera, magazine and motors, regardless of the outside temperature. Install low-voltage heater units at strategic spots, to maintain the camera temperature. Follow example (c) for lubrication and proper spacing. Add a blimp-type fabric cover to the camera exterior to aid the small heaters, keep out blown snow and prevent contact of flesh with cold metal.

In the past several years, cameras winterized with all of the above methods have been used with varying degrees of success by the U.S. Navy and commercial companies. Cameras such as Eastman Cine Magazine, Cine Special II, and K-100; Mitchell 35mm and 16mm; Bell & Howell 200M, 70DA, 70KM (Fig. 1) and the 35mm Eyemo, as well as others, have been used quite successfully in both the Arctic and Antarctic. Failures usually occurred when attempts were made to use a camera with standard lubrication or the same camera both indoors and outdoors.

For very cold weather, the U.S. Navy has used three categories of winterization with different specifications of clearances and lubrication for each:

"Winterized"—For use when temperatures do not fall below −15F.

"Minus 35F"—For use between −45 F and −35F.

"Minus 75F"—For use between −15 F and −75F.

Winterizing cameras to −75F is usually done only for special projects such as for a wintering-over party in Antarctica whose equipment is to be used near or at the Pole, or in high altitudes where temperatures are extremely low. For the Navy's Operation DEEP-FREEZE, the cameras that were to be used during the winter night at Little America were winterized to −75F and the exterior temperature actually reached −78F.

Cameras winterized to these specifications should not be used at temperatures above those recommended, because the clearances would become excessive at higher temperatures if the tolerances had been properly increased for cold weather.

Even though cameras winterized to −75F should not be operated in warm weather, it is wise, when passing through the tropics, to hand-crank them slowly at intervals to insure that the oils do not drain or coagulate in the low spots. For the same reason, they should be stored upside down for short periods.

As with any other task requiring the use of mechanical units, there are a few hints that will ease operations:

(a) Use a separate camera for interior and exterior photography.

(b) Store the exterior camera outside, in outdoor temperatures, but use covers to insure that drifting snow does not enter the housing.

(c) Before using the electric motor on the exterior camera, hand-crank the first few feet to "get her going."

(d) As a general rule, do not operate the exterior camera at more than 24 frames/sec.

(e) *Do not add oil to free a bind,* as the bind will usually have been caused by frozen oil.

(f) If it is necessary to return the exterior camera to a heated room to make repairs, or for any other reason, leave the loaded film magazine outside, as the rise in temperature will cause condensation on the inside of the magazine, which

may result in the film becoming moist. If this occurs, when it dries it will either stick together or cause static marks when unwinding.

(g) It is a good practice to have lenses fitted with large knurled finger-rings so that they can be manipulated while wearing thick gloves (Fig. 2). Cocking-levers on still cameras should be lengthened for the same purpose.

(h) Exposed films should be stored at outside temperatures until ready for shipment. It might be well to mention that the films exposed by Andree in the Arctic were developed thirty-three years after being found in his camera on the ice, and were found to contain reproducible negatives.

(i) Using the new silver-cell type of small battery, it is possible to construct a power vest (Fig. 3) that will power the 24-v motion-picture camera motors as well as the camera heaters. This compact unit will fit snugly to the body, under the outer cold weather garments. The body keeps the batteries warm and the added air space created by the batteries in the vest provides the cameraman with added insulation against the cold.

(j) When using the silver-cell batteries, it is well to construct a small selenium rectifier with a low-amperage charger, complete with meter and switches, to recharge the batteries with a minimum of effort.

(k) Thin silk gloves, worn under the regular gloves and mittens, will permit the cameraman to reload without having skin come in contact with the cold metal.

(l) A small rubber hand-syringe is very handy to blow snow flakes and dust from lenses without causing condensation on the surface.

(m) If the eyepiece ices over from condensation, a very soft-grade artist's graphite pencil may be used in the field to brush or scrape the ice from the surface without damage to the lens.

After the cameras are winterized, there are still other preparations to be made for actual cold-weather photography. The tripods, lens barrels, motors, film magazines and other equipment that require lubrication of moving parts must be winterized as well, but the requirements are not so exacting. The felt pads of the tripods can be delubricated and dusted with graphite or powdered molybdenum sulfide. Magazines can be handled in the same way as cameras.

Triangular canvas sheets, with brass grommets in the corners, can be used to keep tripod legs from sinking into the soft snow. Transporting a studio- or production-type camera over soft snow or hard ice is a problem. The camera can be mounted on a flexible Arctic-type sled similar to military survival sledges. The sled may be used as a tripod base provided the runners are spaced a little further apart than normal. This wide spacing keeps the unit from tipping when being pulled by one man. During the Navy's Operation HIGHJUMP, the Photographic Officer used tracked vehicles (weasels) to mount cameras as well as to transport camera units.

Motion-picture cameras, operated in aircraft, have shot, with difficulty, through open hatches at temperatures of −49F and at altitudes of 8,000 to 12,000 ft during the summer months. During the current IGY program (Operation DEEPFREEZE), photo labs have been fitted out to support the scientific staff at Byrd and Pole Stations. When the U.S. Navy landed its first planes at the Pole this year, during the Antarctic summer, the ground temperature was found to be −58F. The altitude at Pole Station is approximately 10,000 ft above sea level. Admiral Byrd recorded a temperature of −80F at almost sea level during the winter night. If there are photographic projects of a scientific nature to be performed at Pole Station during the winter night, it is currently believed that the outside temperature will be lower than −100F. With present-day cameras, exterior work will be almost out of the question.

After Operation DEEPFREEZE I, LCDR C. C. Shirley, the Task Force Forty-Three Photographic Officer and a veteran of Admiral Byrd's early expeditions, stated at the 1956 Convention of the Society of Photographic Engineers: "To the military photographer, a camera for use in subzero temperatures must be designed with the same careful consideration as the finest machine gun, for to the cameraman, his camera is a weapon. A camera, like a machine gun, must be reliable under the most severe conditions encountered by the combat photographer."

Discussion

Carl F. Turvey (*U.S. Dept. of Agriculture, Washington, D.C.*): Did you have any difficulty with the film in regard to static?

Mr. Conger: I've looked at almost 200,000 feet of film that we've shot this last year and seen no static marks on the film at all. We did, however, have trouble with the edges of the film shearing off due to brittleness, and with emulsion dust building up on the camera gates. For a 400-ft roll, we'd have to clean the gate several times to make sure it wasn't building up. But static in itself, no.

Henry Roger (*Rolab Studios*): Did you have any difficulty with the film being very brittle in cold weather?

Mr. Conger: Yes, definitely. The best example I can think of would be the 4 by 5 film pack; the film pack tab must be pulled very slowly so that the film will not tear or shatter. It will, however, make the curve and it will go around. I've done it at temperatures down to a minus 25 — that's as far as I can verify. The cut film in the graphomatic holders — this is again a still camera — tended to curl a little bit with the cold and jammed the holders so we couldn't use them. In loading a motion-picture camera the cold film is brittle and will break if forced around the tight turns. We intend to test Cronar base film on DEEPFREEZE III.

Mr. Roger: Has very fine powdered graphite been used as a lubricant?

Mr. Conger: Yes it has, on both the still camera shutters and motion-picture camera springs; also on the felt between the tripod pan heads and in numerous places it has been used with good results. However, powdered molybdenum sulfide is a better lubricant for temperatures below 40F.

Gerald Badgley (*U.S. Naval Photographic Center*): Could you please inform us, whether the cameras that you are mentioning have sleeve or ball bearings?

Mr. Conger: The cameras we used contained both sleeve and ball bearings, and I do know of one sleeve bearing failure. On the camera we used, no mechanism modifications were made to the equipment.

Mr. Badgley: In these cameras that fail, did you have an opportunity to examine and find out which type of bearings gave you failures?

Mr. Conger: No, not as yet. The equipment that did fail last year hasn't arrived in the United States, but we will have every camera checked, repaired and reported on. Some cameras will go to the Navy's Overhaul and Repair unit and others will be returned to the manufacturer.

news and reports

Papers for the 83d Convention, April 21–25, Ambassador Hotel, Los Angeles

Since the announcement of the topics and Topic Chairmen in the December *Journal*, p. 778, progress has been made for various sessions, the work for one of which is described in detail below.

By late January, time has nearly run out. The deadline for abstracts to reach Program Chairman Herb Farmer is February 3.

If you have a subject or know about a prospect for a paper or if you have been corresponding with a Topic Chairman about a paper, please advise the Topic Chairman if you can but by all means send at once the information of title, authors and abstract to

Herbert E. Farmer, SMPTE Program Chairman,
c/o Cinema, University of Southern Calif.,
University Park, Los Angeles 7, Calif.

The format of the Convention will very soon be established — the number, sequence, location and concurrency of sessions. For this planning, the Abstracts due by February 3 are required — then the advance copies of manuscripts due the Program Chairman by March 17 are the basis for definite scheduling of a paper in the Final Program.

Abstracts and papers submitted after deadline will be given every feasible consideration but cannot be scheduled without special permission of the Program Chairman and Papers Committee Chairman. Late papers will be assigned to unfilled sessions (whenever there are such) and amounts of time and projection facilities will be made available as best possible—but only in second priority to papers received on time.

Exhibit planning is complete and shown in detail in the announcement on the opposite page.

Papers on Closed-Circuit TV

In October, Topic Chairman Boyce Nemec made 35 formal inquiries of organizations with possible interest and received 24 replies, many with detailed and useful suggestions.

Those who responded were manufacturers of closed-circuit TV equipment, organizations that have studied the market, and persons who have taken part in technical and operating tests of equipment. Of the group circularized, home pay-TV was lowest on the list of specific subjects designated but it is recognized that this may not reflect the feeling of the Society. The greatest interest expressed was in the subject of educational TV, with the emphasis on classroom rather than on large-group education.

Other closed-circuit applications which were mentioned a significant number of times included industrial (group meetings, traffic, personnel monitoring and control) and theater TV.

The responses indicated that, for maximum appeal, the papers presented should deal largely with distribution systems, pickup environment and pickup equipment. In describing applications and operating aspects, authors should avoid over-optimism in describing (or failing to describe) specific limitations.

Case histories will be welcomed and Author Forms should be filled out for each 5-minute or longer case history as well as for 20-minute papers. In presenting brief case histories, authors should describe the problem and present the solution with emphasis on its unique or evolutionary aspects. The presentation should also include a candid appraisal of the results with, possibly, new directions or trends in the field.

1958 Directory for Members

Does the label on the envelope in which this *Journal* came to you
or the April 1957 *Journal* Part II have an error or inconsistency in your address or listing?

The 1958 Directory is planned to have the same general content and arrangement as the 1957 Directory. Please send corrections and suggestions to Society Headquarters. New members and new addresses are expected to be included if received by March 5 and they will be taken into account as far as feasible during the remainder of March. Suggestions for improving the Directory will be welcome at any time.—*Ed.*

Education, East Coast

Ed Schuller, Chairman of the Eastern Subcommittee for Education of Sound Technicians, has just received results of his survey regarding the proposed repeat of the course in motion-picture sound recording that was sponsored by SMPTE at New York University last year. His committee finds that the response is insufficient to conduct a course this spring and plans a course in the fall, instead.

James W. Kaylor, Chairman of the Eastern Subcommittee for Education of Laboratory Technicians, announces that after careful consideration his committee has decided to postpone until September the presentation of the color motion-picture laboratory course originally planned to start in February.

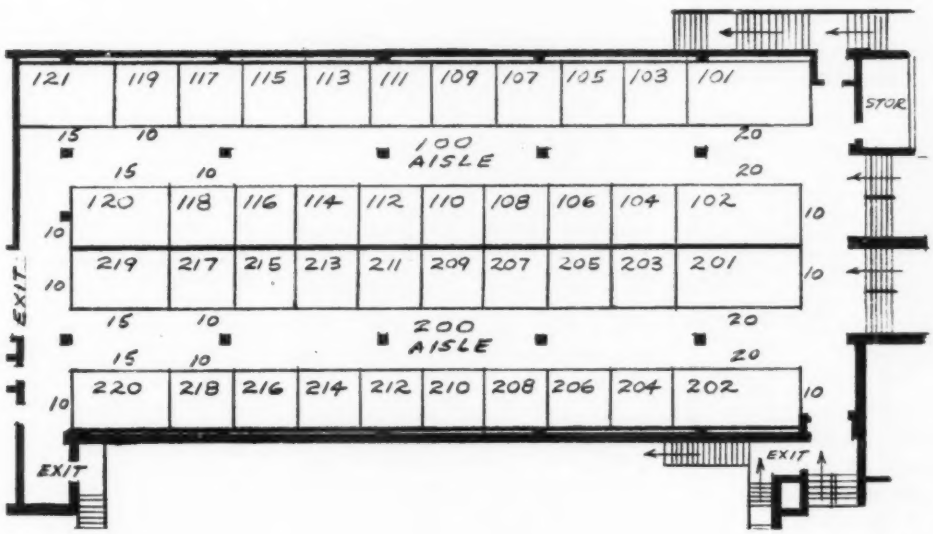
Equipment Exhibit

83d SMPTE Semiannual Convention

April 21-25 • Ambassador Hotel • Los Angeles

Visitors to the Convention are invited to view a display of the newest developments in professional motion-picture and television equipment. A number of these items will be having their first showing on this occasion.

Reservations for booth space are now being made by the Exhibit Committee Chairman John B. Olsson, c/o Houston-Fearless Div., 11801 W. Olympic Blvd., Los Angeles 64:



Rental rates:

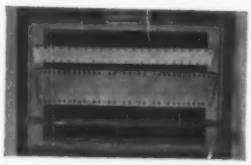
Booths 101, 102, 201, 202	$500
Booths 120, 219, 220	$375
Booth 121	$360
Booths 103, 204	$350
Booths 105–108, 203, 205–208	$300
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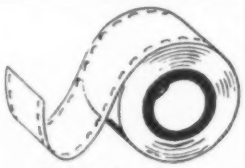


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Education, Industry News

The Eighth National Conference on Standards, held in conjunction with the 39th Annual Meeting of the American Standards Assn., on November 13–15 at San Francisco, included a session sponsored by this Society and the Motion Picture Research Council. The theme of the Conference was "Standards — Key to Progress and Profits," with the SMPTE/Research Council Session entitled "How Standards Help the Motion-Picture Industry." R. A. Isberg of Ampex Corp. was Chairman of the Session which contained these papers:

"Motion-Picture Test-Film Program" by Boyce Nemec, Consulting Engineer, New York.

"How Standards Aid the United States and Foreign Motion-Picture Industries," by Axel Jensen, Bell Telephone Laboratories, Murray Hill, N.J.

"Standards in a Nonstandard Industry," by William F. Kelley, Motion Picture Research Council, Hollywood.

"Proposed Standards for Videotape Transmission," by Ross H. Snyder, Ampex Corp., Redwood City, Calif.

Three members of the Society have been advanced to the honorary grade of Fellow of the Institute of Radio Engineers, effective January 1, 1958. They are: Joseph B. Epperson, Scripps-Howard Television, Cleveland, whose citation will mention his contributions to radio and television broadcasting; Raymond L. Garman, General Precision Laboratory, Pleasantville, N.Y., cited for his leadership in research and development of electronic devices; and Orrin W. Towner, WHAS, Inc., Louisville, Ky., cited for his contribution to wartime electronics.

Seventy-two other leading scientists and engineers will be similarly honored at the IRE National Convention, March 24–27, 1958, at the Waldorf-Astoria Hotel, New York.

Alan Cook and **William H. Metzger** are principals in recent appointments by Ansco, Binghamton, N.Y., in its Professional Motion Picture Products Dept. Mr. Metzger will be Sales Service Supervisor located in the firm's New York office and will supervise the Atlanta, Binghamton, Chicago, Detroit, Dallas, New York and Toronto sales districts. Mr. Cook will be located in Hollywood and will supervise the Los Angeles and San Francisco sales districts.

Eighteen or more Daniel and Florence Guggenheim Fellowships in Jet Propulsion and Flight Structures are awarded annually for graduate study in these fields. The Jet Propulsion Fellowships are for study at Princeton University and California Institute of Technology and the Flight Structure Fellowships are for study at Columbia University. Each grant provides for tuition and a stipend which ranges from $1500 to $2000. An applicant should file credentials with the University of his choice before March 1. Application forms are available from colleges and universities and from firms and organizations specializing in these fields or from Daniel and Florence Guggenheim Foundation, 120 Broadway, New York 5.

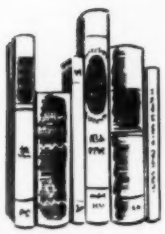
A mutually beneficial exchange of technological information between the United States and European countries is the aim of a program conducted by the International Department of Armour Research Foundation, Illinois Institute of Technology. Under the program, a team of five ARF technologists, headed by Herbert B. Gausebeck, Manager of European Operations, are studying European technological developments of potential value in American markets. The team has headquarters in The Hague, Netherlands. The program is sponsored by 20 noncompeting American firms divided into groups of four in each of five fields: mechanical engineering, electrical engineering, chemistry, chemical engineering and metallurgy.

Rediffusion Ltd., pioneer in wire broadcasting throughout the world, and Skiatron International Corp. have entered into a 21-year agreement for mutual assistance in the pay-TV field in the United States and abroad. Under the terms of the agreement, Rediffusion will survey, install and supervise closed-circuit systems for Skiatron International and Skiatron TV, Inc. As part of the agreement, Skiatron International acquires a 50% interest in Rediffusion Inc., the Canadian subsidiary of the British firm. The British firm will also act as technical advisor in the purchase of equipment. One of the first developments is planned for Montreal.

An International Experimental Film Competition will be held in Brussels, April 21–27, 1958, under the auspices of the World Film Festival. The competition is being organized by Cinémathèque de Belgique (Belgian Film Library). Independent producers throughout the world are invited to participate. All types of experimental productions are admissible. First prize is 500,000 Belgian francs (about $10,000). Films should reach Brussels before March 1. Information is available from Mr. Jacques Ledoux, Curator, Palais des Beaux-Arts, 23 Ravenstein, Brussels.

Seventeen applications for international film festivals were presented to the International Federation of Film Producers' Associations which met in Paris during November. The Federations Administrative Council decided against granting approval to all applicants because it would not be practicable to endorse such a large number. It was decided that in the future the Council's approval would be limited to two classes of festivals: recommended and recognized. National associations would be urged to participate in festivals in the "recommended" category. The "recognized" category would include approved festivals which national associations and their individual members would be free to support to whatever extent was desired.

For the first six months of 1958, the Council approved two recommended festivals, to be held at Cannes and at Berlin; and one recognized festival, at Mannheim, Germany.



books reviewed

Closed Circuit TV System Planning

By Morris A Mayers and Rodney D. Chipp. Published (1957) by John F. Rider Publisher, Inc., 116 West 14th Street, New York 11. xii + 250 pp. Illus. 8½ by 10¼-in. Price $10.00.

The serious inquirer into the nature of closed-circuit TV who is not himself a television engineer need look no farther than this new volume for a carefully assembled and organized report on the present state of this relatively new technique for private communication. Here he will get himself off to a good solid start.

The authors have scanned the trade, technical and engineering literature and have called on their own considerable experience in collecting material for this useful book. It is the first comprehensive review of the range of applications to which closed-circuit TV is well suited and of the nature and function of video systems, including Videotape and color. Its points are made in a once-over-lightly style augmented throughout by illustrations of major system components, many showing particular circumstances of use.

The authors' stated objective is to inform persons in management who are faced with the decision to buy or not buy closed-circuit TV systems or services to meet certain stated company needs. And they seem not to have forgotten their intended reader. Such technical terms as are used are explained. Principal elements of cost are analyzed in considerable detail and the authors are to be credited with great courage for the frankness with which they talk about the dollars and cents aspects of installation and operation. A good case is made for the utility of such systems in "the factory, in offices, schools, hospitals, department stores and a host of other business and industrial areas."

The book is divided into three sections: Applications of Closed-Circuit TV; How Closed Circuit TV Works; and Equipment. Each section includes a brief list of related references that will prove helpful to the reader who wants to know more. In three appendixes there are listed the names and addresses of companies that produce closed-circuit TV programs and are prepared to lease out equipment; U.S. and Canadian manufacturers of closed-circuit TV equipment; the cost of equipment, services and operation; and at the end are a short glossary of terms and a very complete index.

The thorough reader, and particularly the one who has a tough application problem, might wish that more space had been devoted to spelling out the hard facts of use and to evaluating the degrees of success achieved with particular problem solutions.

To cite an example, in the "Applications" section which contains many interesting case histories they report the use by the Bulova Watch Co. of a pair of TV-Eye camera-receiver combinations for simultaneous two-way examination of drawings, parts and the like in the engineering department and shop which are some 500 ft apart. This brings up at once questions of lighting, image resolution, subject contrast, adjustment of the appropriate controls and manipulation of the cameras during the viewing of subject matter that must surely vary widely in size, color, reflectance and specularity. The prospective user will have to ask and get answers to many just such practical questions before he dares risk the substantial investment inherent in the adoption of closed-circuit TV techniques. Perhaps it was not the author's intention to be analytical to such a degree.

Theater television is mentioned. Home-pay or toll TV is not.

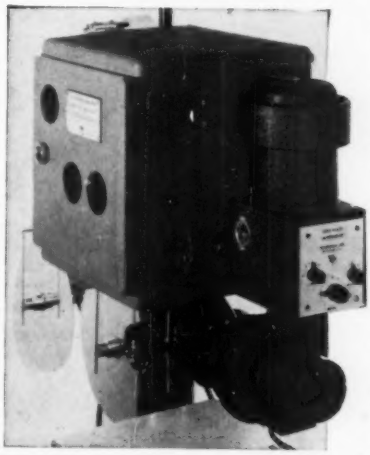
In any event, the newcomer to closed-circuit TV will find that the several hours reading this book requires is time well invested for it will carry him through an honest, comprehensive and comfortably paced familiarization course in this new and promising communications medium.—*Boyce Nemec*, Management Consultant, 141 East 44 St., New York 17.

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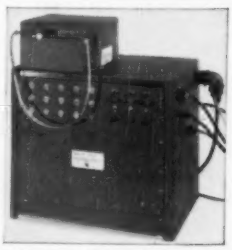
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Keyboard and Punch

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The utmost light efficiency is obtained by the use of 6 interference-type multi-layer, all-dielectric beam splitters, and by the elimination of absorbing trimming filters. The heat absorbing glass is eliminated and a cold mirror, of the interference type, is used instead. All of the interference beam splitters are cemented and therefore permit easy cleaning without risk of damage.

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3-Channel Memory Unit with Reader for automatic operation of light valves, reading in succession—blue, green, red, and storing the introduced information. For easy servicing, commercially available punched tape reader is used as a base.

Keyboard and Punch with 32 combinations for each color—blue, green, red; with an additional channel for introducing other information such as stop, lap dissolves, etc., and with built-in scene counter. Can also be used with Reader to reproduce automatically duplicate tapes and will permit corrections of the tape and continue with the accepted information.

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8MM Cine Manual

By H. A. V. Bulleid. Published (1957) Fountain Press, 46–47 Chancery Lane, London WC2, England, and Rayelle Publications, 76 West Chelten Ave., Philadelphia 44. 257 pp. 156 Figs. 5¼ by 7¼ in. Price $7.95

For an author to turn critic as this writer is doing, requires that he attempt to repress his urge to criticize errors and improper engineering statements, and emphasize the good and positive values of a book. This book, which has 12 chapters, a glossary and 4-page index, is well written in a chatty yet substantial style that is very readable, interesting and informative — in the tradition that has made English writers on film subjects admired throughout the civilized world. It is quite free of the sordid taint of MR (motivational research) that is currently getting such a big play by the advertising bigwigs here in the U.S.A. And it is thoroughly honest in the best tradition of scholarship when the author states in the preface that he was asked to write the book (one would say commissioned); the result is factual yet not in any way genuinely critical of any of the shortcomings that commercial equipment must have due to the compromises necessary to build a piece of equipment that a prospective customer can and will buy.

Before reading this book, the reader must make up his mind that 16mm is really a professional medium today, and 8mm is not — and the literature of the two sizes must be expected to reflect it. The author does put the point across — and it certainly needs to be made — that good 8mm equipment must be accurately made and well engineered if it is to serve its real purpose. Much of Chapters 2 to 6 are catalog and instruction book data, not as such data is usually presented by a manufacturer in the give-away books that accompany the cinemachinery, but possibly as it should be written. While the emphasis in the *Manual* is largely on equipment manufactured by Bell & Howell, this emphasis is not repugnant to this reviewer since it tells clearly what the good features are and how to utilize such equipment advantageously.

Despite the millions of words that have been written on how to make good pictures, there is still plenty of room for new authors and new books on that ever-interesting subject.

The remainder of the book deals with how-to-do and why-to-do information that is so much needed by users and so rarely available to them in lucid style. Too often writers are so concerned with making the matter pleasant reading, that they ignore facts if they ever knew them. This one states the facts that he knows — fairly and honestly.

There are some weaknesses in the portions that touch upon the engineering of cinemachinery, and especially that dealing with sound and sound recording. They show up in the glossary as well as in the choice of nomenclature within the text. If one accepts the language customary in the camera sales salon as the base, the text is without reproach. But the explanation of synchronism on page 150, for example, is somewhat inaccurate if we sit in judgment as engineers. And he has not even mentioned soundtrack striping!

The use of hybrid English-American nomenclature and treatment could prove a little disconcerting to a large body of our not-too-erudite American camera magazine fans. Despite this, and despite the absence of engineering rigor in its writing and approach, I would heartily recommend it to any and all who would take 8mm pictures for personal use. And this recommendation includes engineers who design 8mm cinemachinery as well as those who do not. There are few who will read this little 257-page book without obtaining a useful idea or information from it. That alone is sufficient recommendation for its purchase by anyone who owns or hopes to own 8mm equipment, especially Bell & Howell. And there will be many. Good show. — *Wm. H. Offenhauser, Jr.*, Consulting Engineer, New Canaan, Conn.

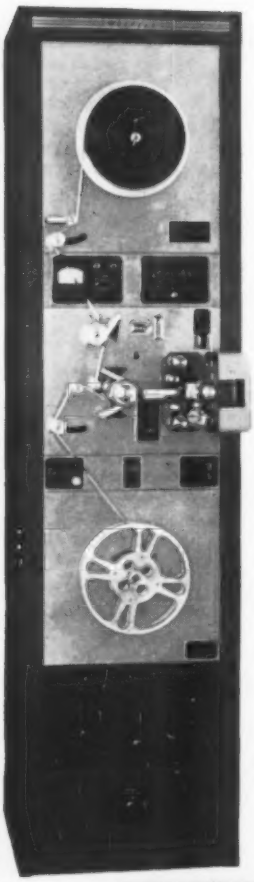
The Movies

By Richard Griffith and Arthur Mayer. Published (1957) by Simon and Schuster, Inc., Rockefeller Center, 630 Fifth Ave., New York 20. xiii + 437 pp. + 5 pp. index. Profusely illus. — about 1000. 448 pp. 9 by 12-in. Price $15.00.

To those of the general public who enjoy the movies as drama and entertainment, this huge volume will be a library in itself — a library covering the history of the American movie industry and of the men and women who directed the pictures, produced them, and acted in them. But to the select group of men who were themselves pioneers in this robust and lusty

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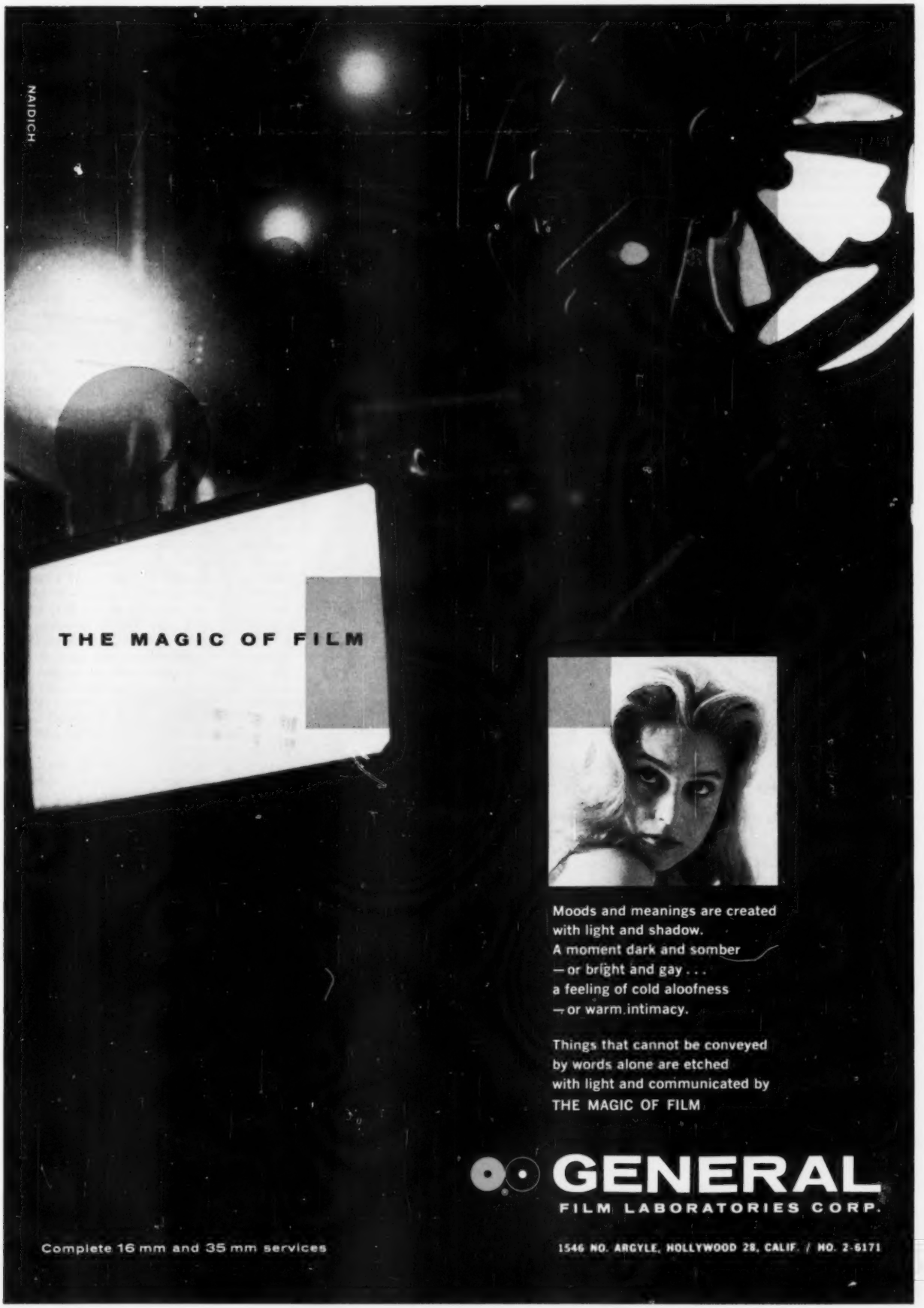
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industry, this book will be particularly welcome as a vivid account of their own efforts.

Much of the interest of the book lies in the excellent still photographs of the films discussed. These are apparently printed "straight," without retouching, so that the quality is consistent with the actual screen presentation. The fine detail and tone values of Georges Melies' hand-processed films of about the year 1904 can thus be truly appreciated, in contrast to the "soot and whitewash" of many films that followed. The text provides a highly readable running commentary of business facts, box-office receipts, production difficulties and other material of interest.

A noticeable flaw is that the approach is in an overly popular vein. Persons discussed are, for the most part, "fan" personalities. For example, Terry Ramsaye and Edwin S. Porter, together, rate less attention than Hedda Hopper. The chapter on "The Birth of the Movies" perpetuates the misleading popular myth by which Thomas A. Edison becomes the sole inventor of the movies. There is not even a single brief mention of Thomas Armat's major contribution, namely, the development of a workable machine for projecting onto a screen. However, despite this one objection, the book can be appreciated as a significant documentary account of the motion-picture world of yesterday and today.—*Bernard D. Plakun*, General Precision Laboratory, Pleasantville, N.Y.



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The Liveliest Art

By Arthur Knight. Published (1957) by The Macmillan Co., 60 Fifth Ave., New York 11. xiii + 383 + 16 pp. illus. 5½ by 8¼-in. Price $7.50.

Subtitled "A Panoramic History of the Movies," this lively and thorough history is panoramic not only in time but also includes what has been in, and behind, the making of motion pictures for more than a century.

Beginning with Roget who set forth in London in 1824 his theory of "The Persistence of Vision With Regard to Moving Objects," succinct attention is given to all the scientific and technical developments up to the recent wide-screen aspects which, naturally, cannot now be treated definitively as history, though the chapter "The Shape of Things to Come," ably closes the text.

Although the film director's role is quite properly the heaviest part in this script, the balanced approach is epitomized as the author speaks of ". . . the three points in the triangle of film creation — the inventor, the artist and the businessman. One could scarcely function without the others . . ."

With the inventor most in mind, our reading was a happy enough experience, though the tautness in a book of this size naturally requires general statements to which we, with many *Journal* historical articles in mind, would apply small adjustments or qualifications. Thus, even though names from the Society's Honor Roll and the names of a very goodly number of SMPTE members currently active on the technical or producing scene appear in this book, the engineer will be constantly on the alert to challenge the text — but he will find little or no basis for general complaint. The author has been true to his aim — he says that "the history of the film is largely an account of directors the world over who, experimenting with the machinery of the inventors, found ways to create entertaining, stimulating pictures for their audiences."

Besides a good general index, there is a 10-page index to film titles which are in turn keyed to a 2-page listing of 16mm film sources. The author has included a nicely annotated list of "100 Best Books on Film" which will remind many of us of other books we have also enjoyed.—*V.A.*

Photojournalism

By Arthur Rothstein. Published (1956) by American Photographic Book Publishing Co., 33 W. 60 St., New York 23. viii + 200 pp. Profusely illus. 7½ by 10 in. Price $5.95.

Although by "Photojournalism" Arthur Rothstein refers specifically to photographic reporting with the still camera, there is much to stimulate the motion-picture cameraman in this well-thought-out book. Like many primers, it can serve not only as introductory material, but as a marshalling force for ideas that the veteran has accumulated and never sorted. Mr. Rothstein is Technical Director of *Look* and it was he who took some of the now classic pictures used during the thirties by the Federal Security Administration to in-


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struct the public in the facts of the desperate situation in the Dust Bowl. Hence he knows whereof he speaks when he discusses types of pictorial reporting, the functions of the various members of the "team" — photographer, editor, laboratory, etc. — and the ethics and the law of photojournalism. Chapters on Creative Images, Progressive Continuities, and Photographic Narration are of particular interest in relation to motion pictures.

Quarterly supplement No. 74 has been added to the *Photo-Lab-Index* loose-leaf encyclopedia published by Morgan & Morgan Inc., 101 Park Ave., New York 17. Included in the Supplement is information on various types of new developers and color printing methods. Subscription rate is $4.00 a year. Supplement service is available to subscribers.

Elements of Color in Professional Motion Pictures has been chosen by American Cinematographer, 1782 N. Orange Dr., Hollywood 28, as one of the 10 books on subjects dealing with basic cinematography which it recommends to its readers. The magazine cautiously refrains from applying the word "best" to its list. In the article in the December issue of the magazine which describes the books selected, "Ten Good Books of Cinematographic Knowledge," by Frederick Foster, the author states "...one can always find differences of opinion on books as with horses, food and women. But in these volumes will be found the answers to countless questions and problems, instruction on basic motion-picture photography, treatises on the procedures employed in making professional motion pictures, and overall — the professional advice of men respected in their field."

Other than the Society's publication, *Elements of Color*, the books selected are: *Film and Its Techniques* by Raymond Spottiswoode; *Handbook of Basic Motion Picture Techniques* by Emil Brodbeck; *Pictorial Continuity* by Arthur L. Gaskill and David A. Englander; *Dynamics of the Film* by Joseph and Harry Feldman; *Films in Business and Industry* by Henry Clay Gipson; *Movies for TV* by John H. Battison; *Industrial Motion Pictures*, Kodak Publication P18, *16MM Sound Motion Pictures* by W. H. Offenhauser; *Painting With Light* by John Alton. With two exceptions, *Pictorial Continuity* and *Films in Business and Industry*, these books have all been reviewed for the *Journal;* the first has interest mainly for amateurs and the second is a nontechnical book.

A special issue of *Audio-Visual Communication Review* (Vol. 5, No. 3) is a 120-page book, "Graphic Communication and the Crisis in Education." The book expresses ideas developed during two conferences at Yale University Institute of Human Relations, September 18–19, 1953, and April 23–24, 1954. Author is Neal E. Miller, Professor of Psychology at Yale University. Twelve authorities in the fields of psychology, sociology and education and representatives of industrial firms collaborated with Dr. Miller in preparing the book. Among the authorities was John Flory, Advisor on Nontheatrical Films for Eastman Kodak Co., whose most recent contribution to the *Journal* (August 1957, pp. 458–461) is an article on "Economic Impact of the Audio-Visual Field."

The book is divided into two sections: Part I, "Barriers to Optimum Use and Suggestions for Overcoming Them," and Part II, "Scientific Principles for Maximum Learning From Motion Pictures."

In discussing the resistance to pictorial techniques displayed by many teachers, the author stated that one reason for this resistance is that teachers "run into so many frustrations in trying to use the equipment." One suggestion made in this section of the book is that, "Means should be found to keep equipment manufacturers in touch with the problems of the classroom.... One way of doing this would be to set up a liaison working group under the joint sponsorship of the Society of Motion Picture and Television Engineers, the National Education Association and the American Council on Education."

The book is available in paper bound and cloth bound editions and is priced at $1.25 and $2.00, respectively. Checks are payable to the Department of Audio-Visual Instruction, National Education Association, 1201 16th St. N.W., Washington 6, D.C.

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E. Ray Arn, president of Film Associates, (with more than a decade of experience in continuous film processing) has this to say about his Filmline R-90 processor:*

"Now that we have over a year of service with almost two million feet of reversal film processed, I feel I can give you a good picture of our feeling regarding our Filmline processor. It is a pleasure to run day after day without keeping our fingers crossed. Our other self-contained processor was a continual headache, in troubles with clutches, bad rollers, and rising elevators. We have found with other processors we've owned in the past, that troubles usually begin after four to six months of service.
You are to be commended on your fine products, and you may rest assured that we are most happy with, and most heartily endorse Filmline processors."



Illustrated: Filmline Model R-90. 16mm Reversal & Negative/posifive processor. Speeds to 90 feet per minute. Completely equipped $14,800.00

*After 14 months of 100% performance

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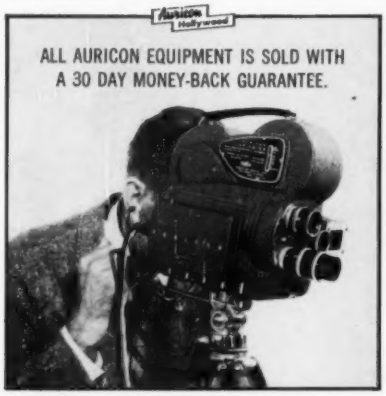
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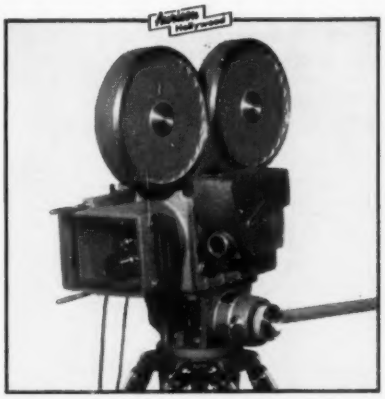
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"CINE-VOICE II" 16 mm Optical Sound-On-Film Camera. ★ 100 ft. film capacity for 2¾ minutes of recording; 6-Volt DC Convertor or 115-Volt AC operation. ★ $795.00 (and up).



"AURICON PRO-600" 16mm Optical Sound-On-Film Camera. ★ 600 ft. film capacity for 16½ minutes of recording. ☆ $1871.00 (and up) with 30 day money-back guarantee.



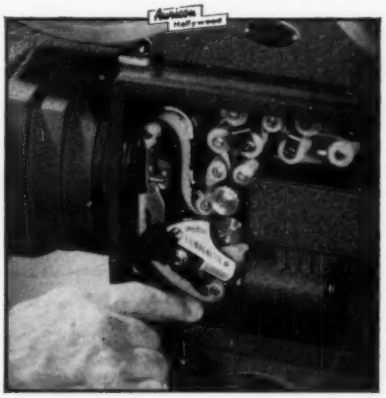
"SUPER 1200" 16 mm Optical Sound-On-Film Camera. ★ 1200 ft. film capacity for 33 minutes of recording. ☆ $5667.00 (and up) complete for "High-Fidelity" Talking Pictures.



SOUND RECORDER — Model RM-30 . . . 1200 foot film capacity, synchronous motor for "double-system" 16mm Optical Sound-On-Film operation. ★ $3630.55 (and up)



PORTABLE POWER SUPPLY UNIT — Model PS-21 . . . Silent in operation, furnishes 115-Volt AC power to drive "Single System" or "Double System" Auricon Equipment from 12 Volt Storage Battery, for remote "location" filming. ★ $269.50



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TRIPOD — Models FT-10 and FT-10S12 . . . Pan-Tilt Head Professional Tripod for velvet-smooth action. Perfectly counter-balanced to prevent Camera "dumping." ★ $406.25 (and up).

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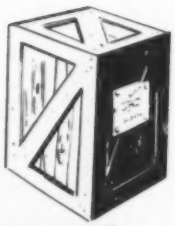
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Auricon Hollywood

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new products

(and developments)

Further information about these items can be obtained direct from the addresses given. As in the case of technical papers, the Society is not responsible for manufacturers' statements, and publication of these items does not constitute endorsement of the products or services.

Technirama, the wide-screen system developed by Technicolor Corp., is about to employ new camera equipment, according to recent issues of the British *Kinematograph Weekly*. There is already a prototype of a new streamlined blimp, reported as very little larger than the Mitchell black-and-white blimp. It is made of a light alloy casting and has been illustrated on the Technirama camera equipped with 2000-ft magazine. Also reported are new lightweight Technirama cameras weighing only 50 lb with a 1000-ft magazine.

Some technical data and specifications for Technirama were given in this column in the April 1957 *Journal*. A recapitulation, chiefly of the taking data, follows.

Similar in some ways to both VistaVision and CinemaScope, Technirama employs partial anamorphism in the camera and further anamorphosis in the printing operation. Reported used for camera negative is Eastman Color Negative, with release prints supplied by Technicolor's dye transfer process.

Film (35mm) travels horizontally through the camera, with the image taken at a 1.5 compression via an anamorphic optical system earlier reported as designed by N. V. Optische Industrie of Oude Delft, Holland. The camera aperture is 1.420 by 0.715 in.

From the partially anamorphosed negative a further squeeze to a lateral compression of 2:1 in the release print is accomplished by Technicolor with separation matrices made by optical printing with the image turned 90° so that film travel in the matrices and the release prints is vertical.

Technirama release prints made by dye-transfer process have an aspect ratio of 2.34:1 for single-track, photographic sound; and 2.55:1 for four-track magnetic sound. The photographic track is standard, 0.100 in. wide; and the magnetic track standards are three 0.063 in. wide, and one 0.041 in.

Further recapitulating: negative (double-frame) travels horizontally right to left in the camera at 24 frames/sec or 180 ft/min; positive (single-frame) travels vertically (down) in the projector at 24 frames/sec or 90 ft/min. Release prints with four-track magnetic sound have been made on 35mm film with CinemaScope perforation holes; and prints with the single, photographic track, on 35mm film with Eastman standard perforations.



The Spectra Professional is announced as an improvement of the Model A incident light exposure meter by Photo Research Corp., 837 North Cahuenga Blvd., Hollywood 38. Production of the Model A was discontinued a few years ago because of contractual obligations with Donald W. Norwood. Upon expiration of the contract, certain improvements have been made in the meter and the new model put into production. Included in the price of $97.50 are the disk, grid, 12 film-speed slides and carrying case.

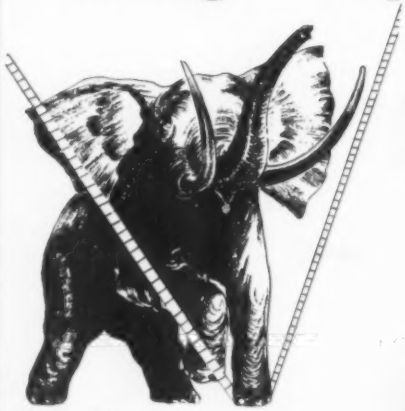


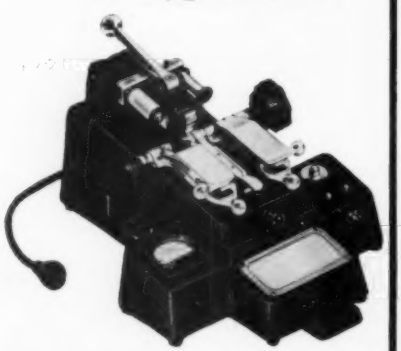
The Camera Pan and Tilt Head Type III introduced by W. Vinten Ltd., London, uses a new design principle to achieve balance and flexibility. The design is based on a simple mechanical principle which allows the center of gravity of the camera to move in a horizontal line parallel to the head mounting when tilted in either direction without making use of a spring or hydraulic counterbalance system. A tilt of up to 50° in either elevation or depression can be obtained. Now in use in TV studios in Europe, the unit has been found to be a suitable mounting for cameras fitted with zoom-type lenses. Information on the equipment can be obtained from Cinematograph Export Ltd., 715 North Circular Rd., London NW2.

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The 1958 Kinevox-Hallen Model 616, a 16mm portable magnetic recorder/reproducer is equipped with the Academy Award winning Davis filter to assure smooth, flutter-free film motion in reverse or forward operation. The sprocket film drive is powered by a salient pole type synchronous motor equipped with nylon gears. The 28-lb unit is designed for portability and economy. To reduce weight and power consumption, the takeup and rewind reels are powered by clutches from the drive gear.

Specifications include: film capacity, 800 ft standard up to 1600 ft Mylar; film speed, 36 ft/min standard 16mm sound speed; footage counter, 3-digit: track placement, standard edge track (other track positions on order); monitor, simultaneous with 10-amp playback amplifier (accessory); frequency response, essentially flat from 50–8000 cycles; distortion, less than 1.5% total harmonic at 400 cycles; signal-to-noise ratio, not less than 50 db; output level, normal 4 dbm; output impedance, 500 ohms balanced or unbalanced; flutter, less than 2%; microphone input, 50/250 ohms impedance; high level input, high impedance unbalanced; power, maximum 55-w, 115-v, 60-cycle, and 50-cycle 115-v or 220-v available.

A product of Kinevox-Hallen, a Division of Electromation Co., 1646 18th St., Santa Monica, Calif., the model was exhibited in New York in December by the distributors, S.O.S. Cinema Supply Corp., 602 W. 52 St., New York 19. It is priced at $895.

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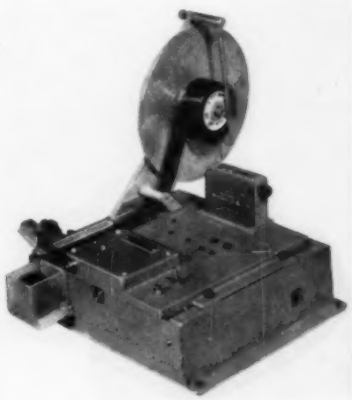
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Protective film treatments... complete film distribution servicing ...and other special services to aid producers and distributors.



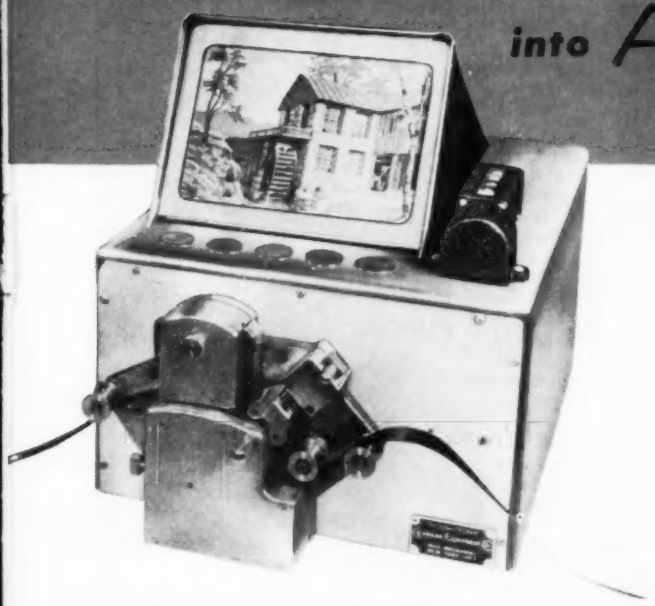
A motor-driven 35mm cutter which can operate continuously or intermittently has been announced by the H. L. Instrument Co., 1104 Fair Oaks, South Pasadena, Calif. The machine has an automatic operating rate of 110 pieces of film a minute, or it may be placed in a semiautomatic position for single cuts by turning a switch. The cutter is completely mechanical and has no electronic parts. It is priced at $395.00 without optional equipment which includes a roll holder and film collecting box.

Freon-TF solvent, a product of E. I. du Pont de Nemours & Co., Wilmington, Del., is a solvent developed especially for safe film cleaning. The solvent (chemical name: trichlorotrifluoroethane) for cleaning cellulose acetate and Cronar film bases and emulsions is described in an illustrated brochure available upon request from the company.

A new Kodak Film Cleaner that eliminates any hazard from flammability in cleaning black-and-white and color negatives or transparencies, has been introduced by Eastman Kodak Co. It is applied with a soft, lintless cloth to remove dust and dirt from films. Available through Kodak dealers it is listed at 90 cents for a 4-oz bottle.

Tuff Coat, a noninflammable film cleaner, is a product of Nicholson Products Co., 3403 Cahuenga Blvd., Los Angeles 28. The cleaner contains no carbon tetrachloride and is announced as a cleaner for all types of movie and still film and also as providing invisible impregnation to kill static and provide lubrication. Treatment is estimated at 15 cents a 1000 ft or $12.00 a gallon, $5.00 a quart.

Everything under the Sun to translate SCRIPTS into Film



16MM Professional Film Viewer—

Makes film editing a breeze. Easy threading, portable, will not scratch film. Enables editor to view film from left to right on large 6" x 4½" brilliantly illuminated screen. Sound Reader and/or Counter can be easily attached. Available in 35mm model. 16mm PROFESSIONAL FILM VIEWER **$350.00.** 35mm Model **$500.00**

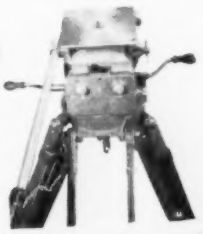
As every Pro knows, CECO carries just about every quality product under the photographic sun.

But you need more than cameras, tripods, dollies and recorders—you need more than lenses, viewers, blimps, generators and lights.

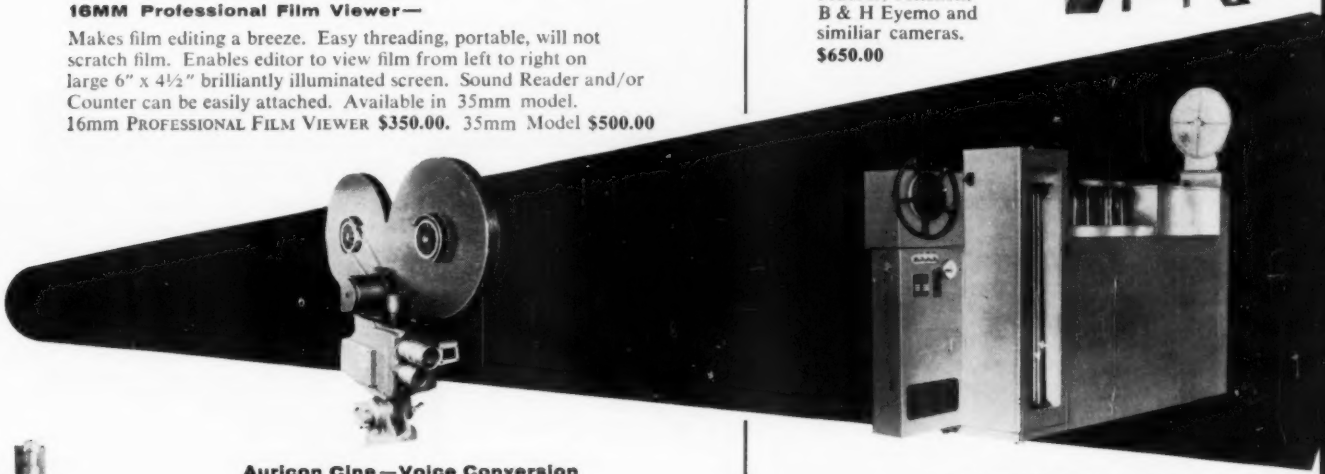
You need *answers* to important questions—how to successfully translate scripts into film. No one man knows all the answers. That's why CECO employs a staff of experts in every category of film-making—cameras, recording, lighting and editing. Collectively we have all the answers to help make you an outstanding producer, director or cameraman.

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CECO Small Gyro Tripod

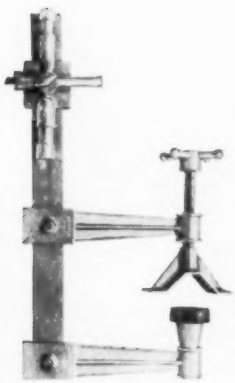


Features "controlled action" with slow and fast speeds for both panning and tilting. Weighs only 19 lbs. Ideal for 16mm Maurer, Mitchell, B & H Eyemo and similiar cameras. **$650.00**



R-15 FILMLINE Developer

Develops reversal and negative-positive film at 1200 ft. per hour. Has variable speed drive. Permits complete daylight operation. Exclusive overdrive eliminates film breakage. **$2,995.00**



Auricon Cine—Voice Conversion

Cine—Voice Camera modified to accept 1200-ft, 600-ft, and 400-ft. magazines; has torque motor for take-up. Also includes Veeder footage counter and 3-lens turret. Conversion only—$450.00 less magazine.

GROVER Grip

Holds a light wherever space is tight. No springs, no slip. Has 8" spread. Both ends padded against marring. Weighs less than 2 lbs. **$6.85**

TEWE Directors View Finder Model C

For academy aperture, wide screen, cinemascope, vistavision and IO TV cameras. Zoom type with chain & leather case **$100.00.**



ADDITIONAL PRODUCTS

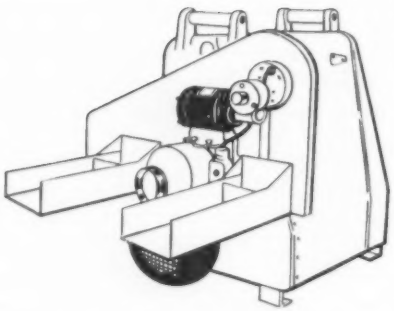
Camera Equipment Company offers the world's largest and most comprehensive line of professional cameras, accessories, lighting and editing equipment. The quality product isn't made that we don't carry. See our Splicers, — exposure meters — projectors — screens — marking pencils and pens — editors gloves — editing machines, racks, barrels, and tables — stop watches.

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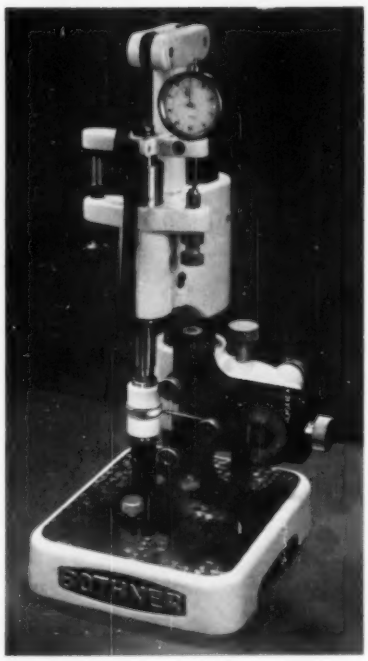
The SM.2, Genarco Slide projector, a 3000-w projector with a 70-slide changer is a product of Genarco Inc., 97-10 Sutphin Blvd., Jamaica, N.Y. The source of light is a 3000-w tungsten lamp with a life expectancy of 100 hr. Electric blowers of 280 cu ft/min capacity cool the mechanism and the slides which are also protected by a dichroic heat reflecting filter. The projector is supplied with a standard wide-angle lens suitable for rear projection on a translucent screen or with all dimensions of lenses for operation from a theater projection booth or from the back of a ballroom.

A 9mm positive projector carbon has been added to the Suprex line of copper-coated carbons produced by National Carbon Co., 30 E. 42 St., New York 17. The company is a division of Union Carbide Corp. The new carbon is recommended for operation in the 65- to 80-amp current range and is designed to produce up to 10% more light while burning at a considerably slower rate than earlier carbons in its current range.

A honeycomb light-directional screen for viewing under bright ambient light conditions has been announced by Hexcel Products Inc., 951 61 St., Oakland 8, Calif. The screen, now being tested for commercial production for home TV sets, is made of aluminum in the form of hundreds of small hexagonal cells with very thin walls. The removable screen is attached to the front of the TV screen with magnetic clips. Honeycomb screens are also being considered for drive-in theaters and audio-visual uses.

The screen functions by blocking a large proportion of ambient light from the viewed surface, each cell of the structure acting as a hood or light-shield limiting the entrance angle of straight-line light. The degree of shielding and the arc of the viewing angle are determined by the cell size and depth. The optimum viewing angle has been determined to be 80°, or 40° each side of center. With the screen in place, the normal 180° exposure to ambient light is reduced to only 80°. The reduction is reported as usually sufficient to allow effective image contrast even in direct daylight.

The subject of honeycomb directional viewing has been explored in an article, "Minimizing the Effects of Ambient Light on Image Reproduction" by G. L. Beers, published in the *Journal* for June 1957, pp. 347–354.



The newly developed WB-30 lens centering tester, manufactured by Wilhelm Bothner & Co., Germany, makes it possible to check all physical specifications of centered and beveled lenses in one operation. The accuracy of this tester is reported to correspond to that of optical instruments used for similar purposes. Testing of thickness, diameter, cylinder, lower and upper bevel can be accomplished with all lenses centered and beveled by either automatic or conventional methods. Work diameters range from 5mm., $\frac{1}{4}$ in., to 120mm, $5\frac{3}{4}$ in., with edge thickness up to 40mm, $1\frac{3}{4}$ in. Further information is available from Alfa American Corp., 303 W. 42 St., New York 36.

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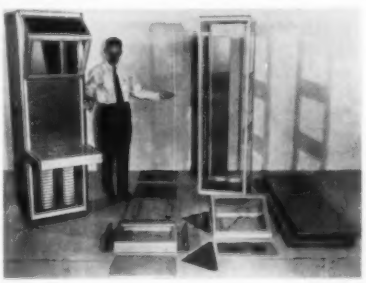
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The Elgin Metalformers Corp., 630 Congdon Ave., Elgin, Ill., has expanded its Emcor Modular Enclosure System to include new component parts and to increase its load-carrying capacity. The system features basic "building block" frames and various panels and sub-parts that can be assembled to make various types of interconnecting, expandable enclosures. A catalogue listing the cabinets and component parts is available from the company. Request should be addressed to John J. Sullivan, field sales supervisor, or Harold Bowen, sales correspondent.



AUTOMATIC TRI-FILM PROCESSOR

UP TO SIX FEET A MINUTE WITHOUT LOSS OF QUALITY!



THE transportable Mark 3 Automatic Tri-Film Processor develops and dries 16, 35 or 70 mm. film at 1½, 3 or 6 feet a minute! Four 400-ft. 16 mm. films can be handled simultaneously—or two 400-ft. 35 mm films—or one 400-ft. 70 mm length. The various film sizes are accommodated by simple adjustments of film separators. Separate temperature control of the processing solution is possible on each tank from 60 to 110 degrees F., within ± 1 degree. The latest high temperature chemical resistant plastics and Type 316 stainless steel are used in all chemical areas. Processing is controlled by a mechanical program unit after the film is loaded into the machine—no special "leader" or continuous tapes, chains or sprockets are used.

The need for stop baths and interbath rinses, normally required in many processes, is virtually eliminated because of a positive squeegee roller design.

A high-efficiency blower system and electrical heating ensure rapid drying in the machine. The Processor is perfect for newsreels, TV news on film, motion picture "rushes" in the field,—in all cases where speed plus quality are essential. Write for literature and quotations.

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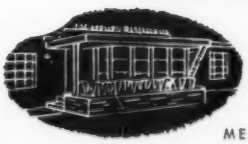
AUTOMATIC TRI-FILM PROCESSOR TYPE T246 Mk3

Size:	54" long, 22" wide, 51" high
Weight:	400 lbs.
Power Consumption:	5 KVA maximum single-phase: 110 volts, 45 amps, or according to customer requirements
Process Capacity:	1 to 4 rolls 16 mm ; length 1 or 2 rolls 35 mm ; to 1 roll 70 mm ; 400 ft.
Rate of Processing:	1½, 3 or 6 ft. per min.

Temperature-controlled solutions and dryer. Daylight operation except loading of film into magazine. Processes perforated or plain film.

Canadian Applied Research Limited

(formerly PSC Applied Research Limited)



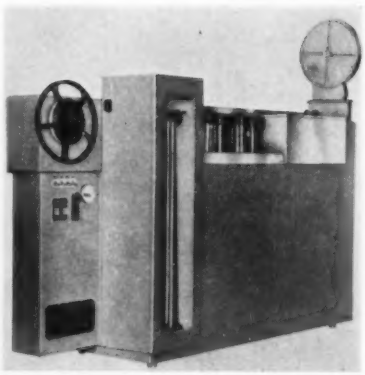
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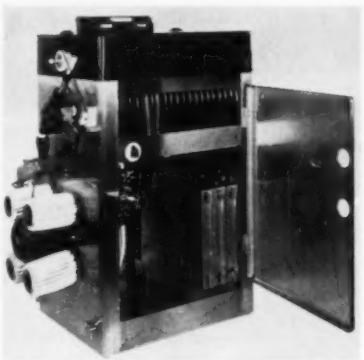


The Tewe Model "C" zoom-type viewfinder has been introduced by Camera Equipment Co., 315 W. 43 St., New York 36. Designed for directors' use, it is calibrated for Academy aperture, CinemaScope 255 and 233:1 as well as for image orthicon TV cameras. Calibration for VistaVision ratio is also included. It is priced at $100.00 complete with leather carrying case and chain.

Model R-15 Combination Reversal and Negative-Positive Processor is a product of Filmline Corp., Milford, Conn. Designed for ease of installation and economy of operation, it does not require a darkroom. Features include precision-machined over-



drive components, which are Filmline's friction-type transport system. The tanks are fabricated from heavy-gauge stainless steel and are heliarc welded to government specifications. Tank fittings and parts in contact with solutions are of stainless steel or inert materials. It is priced at $2795.



The Andre Debrie Mfg. Corp., 114-01 14th Rd., College Point 56, N.Y., has announced a new daylight developing machine, the Aiglonne 16mm Black-and-White Reversal. The new machine processes all types of black-and-white films. Features include 23 processing tubes, one of which combines rinse and re-exposure. Footage output ranges from 7 ft/min at 68 F to 12 ft/min at 82 F. Film footage per volume of solution is approximately 250 ft/l. Test made with Tri-X and Plus-X films showed the total processing time to be 11.5 min. The unit weighs approximately 450 lb and the main housing and reserve tanks are of #316 stainless steel.

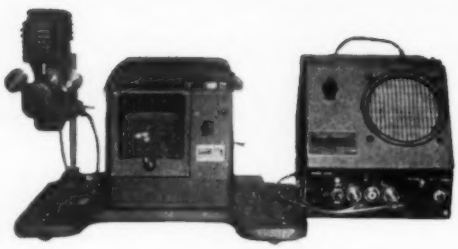
Two other Aiglonne daylight machines, Model DS for black-and-white 35mm and for 16mm, respectively, have been redesigned for increased efficiency and with added features. All three machines are now manufactured in the United States. The 35mm model is priced at $5,650.00 and the 16mm at $6,450.00. The new reversal machine is priced at $7,650.00. Prices for each of the three models are for the complete unit including a dolly.

A magnetic soundhead adaptation for the Arriflex 16mm camera has been introduced by Rank Precision Industries Ltd., 37-41 Mortimer St., London W1. Designed to record directly onto prestriped magnetic film while shooting is in progress, the 3-lb unit consists of a soundhead and recording

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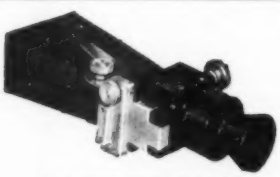
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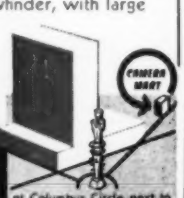
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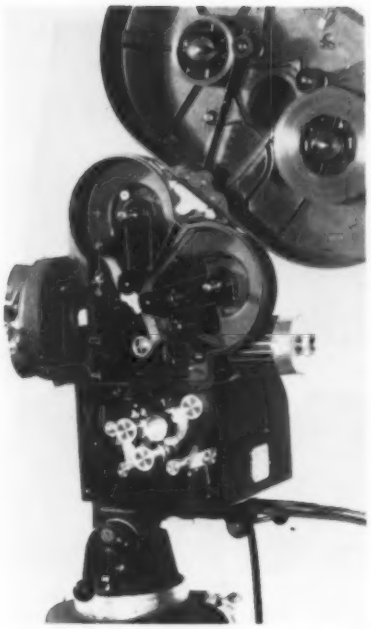
dealers

NEW YORK – camera equipment co., 315 w. 43rd st. new york 36. judson 6-1420. cable address CINEQUIP.
CHICAGO – zenith cinema service, inc., 3252 foster ave., chicago 25, ill. irving 8-2104.
SAN FRANCISCO – brooks camera co., 45 kearney st., san francisco, calif. exbrook 2-7348.
INDIA – kine engineers, 17 new queen's rd., bombay, india.

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amplifier. The soundhead, which contains the film speed stabilizing system together with the record and playback heads, is fitted to the camera base (shown above with the doors removed).

The equipment features a transistor recording and mixing amplifier unit with the following specifications:

Microphone inputs: Two, for direct connection from microphones of 20- to 2000-ohm impedance. Optimum impedance for best signal-to-noise ratio is approximately 500 ohms.

Gain controls: Two, one in each input channel.

Maximum sensitivity: 0.2-mv input for full recording level at output.

Recording frequency characteristic: In conformity with C.C.I.R. standard.

"Music" characteristic: ±2 db 100/8000 cycles.

"Speech" characteristic: 10 db attenuation at low-frequency end of spectrum.

Recording H.F. bias: 40 kc.

Audio monitoring: By means of headphones; adequate power for moving-coil type if desired; monitoring either "direct" off incoming signal or "playback" off recorded soundtrack.

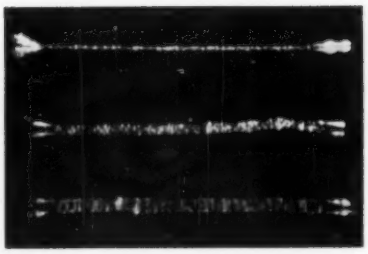
Visual monitoring: By a moving-coil meter which indicates recording level. The same meter can be switched to check bias current and battery voltage.

Battery: One 7½-v dry battery contained within the amplifier case, giving about 60 hr operation.

Weight: 3¼ lb with battery.

Size: 7 by 5¾ by 2⅜ in.

An ultra-high-speed camera capable of taking pictures at five-billionths of one second has been developed by Electro-Optical Systems, Inc., 1001 E. Green St., Pasadena, Calif., for Samuel Feltman Ammunition Laboratories of Picatinny Arsenal, Dover, N.J. The almost incredible shutter speed is based on an application of electronic circuitry to timing and operating. The large-aperture, wide-angle Kerr cell shutter has no moving parts and is hermetically sealed. It is pulsed electronically. The camera was designed for solving special problems of a scientific nature in the study of intense explosions, ultra-high-speed shockwaves, special nuclear reactions and similar problems.



The photograph above shows three aluminum wires 1/1000 in. in diameter and ¼ in. long during electrical disintegration. Explosion of the wires was photographed at three phases in the exploding process: 20 billionths of a second, 30 billionths of a second, and 40 billionths of a second after the discharge was started. The effective exposure time for each photograph was 5 billionths of a second.

Electro-Optical Systems, Inc., was organized in 1956 by A. M. Zarem and F. R. Marshall who earlier worked together on the Zarem camera for Navy high-speed studies.

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John I. Newell, Western Cine Service Inc. of Denver, Colorado says of PRA 400, "Two years ago we obtained a sample of the Hoffman Laboratories developer known as PRA 400. This formula had been very successfully used for fine-grain development of still film. OUR TESTS INDICATED THAT IT WOULD BE VERY WELL SUITED FOR MOTION PICTURE FILM DEVELOPMENT."

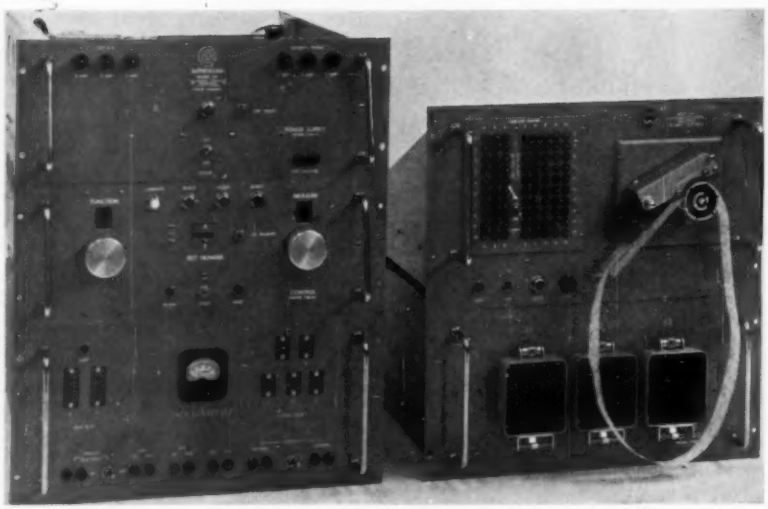
Enough of the prepared powder was obtained to mix 20 gal of developer plus a supply of the PRA 400 replenisher formula. "THIS INITIAL SOLUTION HAS BEEN USED TO PROCESS NEARLY 100,000 FT. OF NEGATIVE FILM IN THE PAST YEAR. THE INHERENT KEEPING QUALITY FAR EXCEEDED EXPECTATIONS. At standard ASA ratings, films were immersed for 2 min at 72 F in this developer. DELIVERY RATE TRIPLED OVER THAT OBTAINED WITH D-76 AND THE COST OF CHEMICALS WAS REDUCED.

"Image quality was noteworthy, grain at a minimum, even in forced processed negatives. Contrast remained normal throughout the scale of the film. No staining or spotting problems have ever been encountered. Direct comparisons of identical negative materials processed to equal gamma in PRA 400 and D-76 have been made. The PRA 400 has proven to be a finer-grain formula. In terms of density range, PRA 400 and D-76 are quite similar. On several occasions Eastman Type 7302 release positive was processed in this developer. The low-contrast result was well suited for telecasting. Kinescope recording film Type 7374 responded very well and proved quite simple to achieve the indicated gamma of 1.1 consistantly. IN POINT OF FACT, WE HAVE BEEN ABLE TO PINPOINT OUR CONTROLS WITH FAR LESS DRIFT THAN EVER BEFORE."

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A pushbutton-operated, tape-programmed tester, the CTI Supertester Model 180, performs complex tape-controlled measurements on electronic and electrical equipment and can be operated by an unskilled worker, as recently announced by the producer, California Technical Industries Div., Textron Inc., 1513 Old County Rd., Belmont, Calif. Production and maintenance tests, including measurements of impedance, a-c and d-c voltage, resistance, leakage and continuity, are performed on a go/no-go basis according to the sequence, value, and tolerance information punched into a standard, 1-in. paper or paper-Mylar tape.

The device can be programmed to energize equipment under test, provide warm-up delay periods and stop when the operator is to perform a manual operation. An accessory printer to provide a permanent record of rejected tests can be supplied. An electrically operated tape punch and a tape duplicator to coordinate the punch with the reader for rapid copying or rapid editing of tapes can also be supplied as accessories.



The Bludworth Marine Underwater TV Camera was recently demonstrated by use in a thorough examination of the apron immediately below TVA's Wheeler Dam at Sheffield, Ala. The equipment which consists of a camera with automatic iris, control unit and monitor was used to inspect the spillway underwater construction for erosion and cracks. With the aid of special lighting a picture was obtained and displayed on the monitor at two to three times normal size to permit clear observation of concrete surfaces 20 ft deep to as much as 100 ft from the control unit. The camera weighs 4 lb submerged and can be operated at depths down to 180 ft. Weight in air is 40 lb. Specifications are recorded as follows: overall dimensions of $6\frac{3}{4}$ in. high, $11\frac{1}{4}$ in. wide and $20\frac{1}{2}$ in. high; lens, 16mm *f*/1.8 (standard); scanning, 525 lines interlaced 2-to-1; sensitivity, usable picture at 5 ft-c in clear water; resolution, 600 lines; signal-to-noise ratio, 30 db; cable length, up to 500 ft, to be specified; tubes, 6BQ7A, 6U8, 6198 (vidicon); power consumption — supplied by camera control unit — 160-w at 117-v 60-cycle, a-c. Further information is available from Bludworth Marine Div., Kearfott Co., Inc., 1500 Main Ave., Clifton, N.J.

A new color TV camera which incorporates printed circuits and transistors in its design has been announced by General Electric Technical Products Dept., Electronics Park, Syracuse, N.Y. Circuitry has been specially designed for good registration of colors without blur or runover into other colors. A newly developed optical system is used to eliminate the need for many glass surfaces through which color signals would otherwise be required to pass. The 215-lb camera measures 34 by 18 by 22 in. A preproduction model was exhibited at the opening of the GE broadcasting center, WGY-WRGB, Schenectady, N.Y. Commercial production is expected in the near future.

A 45,000-w UHF broadcast transmitter designed by the Technical Products Dept., General Electric Co., Syracuse, N.Y., is coupled with a specially designed switching system and a high-gain helical antenna to produce a potential 2 million watts effective broadcasting power. Designed for WDAU-TV, the new Channel 22 at Scranton, Pa., the high-power operation permits better home reception of TV programs in the mountainous areas surrounding the Scranton-Wilkes Barre area. The building housing the unit was designed around the transmitter.

"YOU CAN'T MISS with an ARRIFLEX 35"

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says Jack Painter, A.S.C.
Chief Photographer, Movietonews, Inc.

"I've travelled many times all over the world with my Arriflex 35, and have used it under the most trying conditions. It has never failed me," says the globe-girdling chief cameraman whose Fox Movietone newsreels are shown both here and abroad.

"Arriflex 35 was with me when I shot the Cinemascope color short about the 'A Bomb' called 'Survival City'. Travelogues and documentary pictures—in Cinemascope or 'plain'—both in foreign countries and in the United States were taken with my Arriflex 35. Arriflex was the only camera we had with us—no others could have done the job as well!

"Because it is a reflex camera, the Arriflex 35 has resolved our photographic problems. With an Arriflex 35 you know what you're getting."

Photograph shows Jack Painter, a veteran of 39 years of service with Movietone News, Inc. shooting a street scene with his Arriflex and Pan-Cinor model 150 varifocal lens.



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The Electro-Mechanical Development Co., 2337 Bissonnet St., Houston, Tex., has announced a time-lapse drive unit (Model 1325) for use with the Cine Kodak Special I or II Camera. Designed for flexibility it operates on 120-v 60-cycle a-c or it can be operated from a vibrator power supply operated from a 6-v storage battery. The drive unit may be externally pulsed at random intervals, and can be synchronized automatically with any event which can be made to close with a switch. The 8-lb unit is 11¼ in. long, 8¼ in. wide and 5 in. high. It is priced at $395.

Publication of the Broadcast Transmission Line Equipment Catalog, 2d ed., has been announced by Radio Corp. of America, Commercial Electronic Products Div., Camden 2, N.J. The 68-page illustrated catalog contains descriptions of RCA equipment specifically designed for broadcast stations and closed-circuit use. Contents include information on the new Universal coaxial line, VHF coaxial line, line accessories; power switching, and directional couplers. Reference data and an index are provided.

Equipments for use in educational television are listed and described in a catalogue issued by Radio Corp. of America, Educational Services Dept. 57, Camden 2, N.J. The catalogue lists sound systems, multi-com and auto-dial systems, microphones, speakers, amplifiers, antenaplex, 16mm projectors, tape recorders, TV sets, teaching systems, educational broadcast equipment, electron microscopes, test equipment and electron tubes.

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duced by North Hills Electric Co., 402 Sagamore Ave., Mineola, N.Y., are described in Bulletin 957, available upon request from the company. Each governor has a range of from 1 ma to 30 amp and the current can be electronically switched, pulsed, swept, modulated and programmed.

Two electronic storage display panels developed by Radio Corp. of America were exhibited at the 3rd Annual Meeting of the Institute of Radio Engineers' Professional Group on Electron Devices held at Washington, D.C., in November. The panels were developed separately and are based on two different concepts. An experimental panel 3 inches square, developed at the David Sarnoff Research Center, Princeton, N.J., utilizes a newly discovered property of cadmium selenide to prolong images. The second panel, developed experimentally by an RCA Laboratories team under a Signal Corps contract, is made up of arrangements of photoconductive and electroluminescent materials in tiny cells on a specially fabricated glass plate.

In developing the first panel, it was found that under the influence of applied voltage and exposure to light, the conductivity of cadmium selenide will increase sharply and will remain high for long periods after the light source has been cut off. The panel is comprised of a thin layer of cadmium selenide photoconductor and a layer of electroluminescent material separated by a thin layer of opaque material. The electroluminescent material has the characteristic of emitting light under the influence of an applied voltage. To operate the panel, a voltage is applied across the whole assembly. In darkness, the current is prevented from flowing by the insulating property of the cadmium selenide layer. When the light of the projected image strikes this layer for even 1/100 sec the cadmium selenide becomes conducting in accordance with the pattern of light, allowing current to pass through the opaque layer to the luminescent layer. The electroluminescent material thereupon emits its own light in the same pattern, reproducing the original image. Since the cadmium selenide remains conducting for a long time after the light source has been cut off, the current keeps flowing to generate light in the electroluminescent layer. When the image is to be erased the voltage is interrupted for a fraction of a second. The cadmium selenide then drops back to the insulating condition, ready for the next exposure.

The development of the second panel was based upon the principle of employing light-induced conductivity in the photoconductor material to permit the flow of current to the electroluminescent layer. One panel has been made with 1275 cells to the square inch, and another with 1600. The storage is achieved by an optical feedback process with the light emitted by the electroluminescent material being used to maintain the conductivity of the photoconductor material. Storage is theoretically infinite, but the laboratory models have been limited to storage of about 15 minutes.

A General Electric directionalized VHF helical antenna which can adjust signal patterns to predetermined specifications is being used in an experimental program conducted by WJMR-TV, New Orleans. The station is telecasting certain programs simultaneously on VHF and UHF channels in accordance with an experimental permit issued by the Federal Communications Commission. The experiment is expected to show that this type of simultaneous programming can be pinpointed into specific patterns with no overlap or interference into areas served by corresponding channels.

The Shockley 4-layer npnp Silicon Diode is a 2-terminal switching device developed at Bell Telephone Laboratories. It operates in an open or high-impedance state of 1 to 100 megohms, and in a closed or low-impedance state of less than 20 ohms. Designed for versatility and simplicity, the device is recommended for application in sawtooth oscillators, pulse generators, bistable circuits, ring counters, and various switching functions. Further information is available from Shockley Semiconductor Laboratory, Beckman Instruments, Inc., Mountain View, Calif., or Helipot Corp. Div., Newport Beach, Calif.

An experimental model of a memory device called the "Twistor," which embodies a new concept of memory systems, has been developed at Bell Telephone Laboratories, 463 West St., New York 14. Current research is directed toward the



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3. Loudspeaker Balance Reel	Identical speech and music on four tracks progressively in this order—2,1,3,4	300 ft.*	(LB-1)
4. Stereophonic Reel	Picture with stereo sound and 12,000-cycle control signal on track four	330 ft.*	(ST-1)
5. Flutter Film	3000-cycle, 4-track	50 ft.	(FL-1)
6. Loudspeaker Phasing Film	Signal of uniform level, 400-cycle or 500-cycle frequency-warbled simultaneously on tracks 1,2, and 3, at a 5-cycle rate (specify crossover frequency desired)	50 ft	(LP-1)
7. Constant Level Film	8000-cycle, 4-track to check azimuth	50 ft.	(AZ-1)
8. Channel-Four Film	12,000/1000 cycle	50 ft.	(CH-4)
9. Projector Alignment Chart	Picture Only	100 ft.	(PR-1)
10. Projector Alignment Chart—Optical Track	Picture only, standard sprocket holes (made by Motion Picture Research Council)	100 ft.	CSOS

*These lengths approximate.

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possible construction of magnetic memory arrays by merely interweaving horizontal copper wires and vertical magnetic wires. The name "Twistor" comes from a characteristic of wire made of magnetic material. Torsion applied to such a wire shifts the preferred direction of magnetization from a longitudinal to a helical path. The coincidence of a circular and a longitudinal magnetic field can then be used to insert information into this wire in the form of a polarized helical magnetization, and the magnetic wire itself can be used as a sensing means.

In conventional magnetic core memory devices, conductors must be threaded through the cores to make up a suitable matrix. When a ferrite sheet is employed, either a threading or a plating operation is necessary suitably to locate the conductors. With the Twistor, the ferrite material is eliminated and no threading or plating is necessary. Present indications are that the drive circuits for a Twistor array can be readily transistorized.

The Philco Exicon, an electronic instrument that increases the readability of x-ray negatives through contrast enhancement, was exhibited during the 11th Annual Clinical Meeting of the American Medical Assn. held in Philadelphia, December 3–6. The contrast enhancement device utilizes a flying-spot scanner which converts the information on the x-ray negatives into an electrical signal. The x-ray picture is reproduced for viewing on a TV-type monitor.

Journals Available

These notices are published as a service to expedite disposal and acquisition of out-of-print Journals. Please write direct to the persons and addresses listed.

Issues beginning in 1953 available on a nominal basis. Write: Mitchell M. Badler, 1711 Davidson Ave., Bronx 53, N.Y.

Jan. 1930 through Dec. 1937; Journal SMPE issues; and Jan. 1930 through Dec. 1935, bound volumes of SMPE Journal; SMPE Transactions: Apr. 1919:8, May 1920:10; May 1922:13; Oct. 1922:15; May 1925:21; Oct. 1925:24; Apr. 1927:30; Sept. 1927:32; Apr. 1928:33; Sept. 1928:36; SMPE Membership Listings: 1928, 1930, 1938; SMPE Index and Authors: 1930–1935; SMPE Miscellaneous: ASA Z22—1930; Dim Stab of M.P. Films 1934; ASA Z22—1935; High Intensity Lamps—1935; Program Spring Convention Apr. 26, 1939. Write John Faber, 5 Edgewater Drive, Denville, N.J. Phone Rockaway 9-2623M.

Complete set of Journals from May 1937 to June 1954, including special volumes and membership directories, excellent condition; also Mar., May 1934 and July 1935 issues. Write: Harry R. Lubcke, 2443 Creston Way, Hollywood 28, Calif. HO 9-3266.

Jan.–Dec. 1950; Jan., Feb., Apr.–Dec. 1951; Jan.–Mar. 1952. Also available are vols. 6 and 7 of The Television Society (British) covering the period Jan. 1950 through Sept. 1955. Write: Andrew N. McClellan, 65 Hillside Drive, Toronto 6, Ont., Canada.

Dec. 1946, Feb.–Dec. 1947, 1948-1955 complete. All copies in perfect condition; for sale as entire lot only. Write: Joseph W. MacDonald, 2414 Sullivant Ave., Columbus 4, Ohio.

Jan. 1947 to Dec. 1957 complete and in perfect condition. For sale only as a set. Write: Charles J. Marshall, 2816 Royalston Ave., Kettering 19, Ohio.



These notices are published for the service of the membership and the field. They are inserted three months, at no charge to the member. The Society's address cannot be used for replies.

Positions Wanted

Top Animation Cameraman and technician with over 10 yr experience and 3000 commercial or show direction and production credits, desires position with live studio or TV station. Have own equipment including servo-automatic animation stand, adapted Mitchell 35mm camera, 35mm optical and magnetic recording equipment, rotoscopes, 3-D cameras, complete machine shop, still equipment. Experience as mixer, live cameraman, TV camera editor, art director, puppets, color processor, machinist, set construction, etc. Will relocate anywhere throughout the world. Write: Animated commercials, Inc., 451 West 50 St., New York 19.

Motion-Picture Production. Film student currently studying film at Institute of Film Techniques evenings, wishes full-time job in production, preferably in New York area. Recently finished ½-hr film at amusement park in N.J.; now working on experimental color film using animation. Energetic, with knowledge of many phases of film production; main interest and ambitions are in cinematography. Own 16mm equipment. Write: Leonard DeMunde, 534 Tillman St., Hillside 5, N.J.

Motion Pictures. Argentine, age 43, married, relocating permanently in U. S., seeks position with opportunity for advancement, preferably in California. 23 yr experience in photography, 12 yr teaching at government school; head of motion-picture dept. of local engineering college; familiar with most technical problems; lineal drawing; degree in optics; writer for photog. magazines; workable knowledge English language. Would prefer work in color lab but would consider other positions. For detailed information write or cable: Juan Esnaola, Lagos 1210, Rosario, Argentina.

Studio Technician. Young man (27), recent graduate of TV Workshop, finished in top three of class; thoroughly qualified audio engineer, TV cameraman, floor manager, video operator, dolly and boom operator, etc., with knowledge of scenery, special effects, lighting, color TV principles and operations. Seeking job in TV production. Willing to relocate anywhere (Timbuktu if necessary); will accept modest salary to start. Arthur K. Hirshman, 2242 Bragg St., Brooklyn 29, N.Y. Tel: NIghtingale 6-3997.



Administrative Engineer. The SMPTE's former Staff Engineer, Henry Kogel, is seeking a new position, after 6 years working with SMPTE Engineering Committees and the motion-picture standards program; also serving as Secy, American Standards Assn. Sec. Committee PH22, and Tech. Secy, International Standardization Orgn. Tech. Com. 36, Cinematography; 2 years, previously, develop. engr. with Sperry Gyroscope Co.; B.S. Elec. Eng., Columbia Univ., 1948, after military service as radio off.; recently sales engineer with Century Lighting Inc.; age 38; married; complete resume upon request. Henry Kogel, 19-24 202 St., Bayside 60, N.Y.; Tel. BAyside 9-3574.

Film and TV Production Supervisor. Thirty yr theatrical, industrials, trailers and TV commercials. Ten yr advertising agency experience in radio and TV productions. Will relocate. Resume on request. Write: Don McClure, 4 Pasture Lane, Darien, Conn.

Motion-Picture Production Supervisor-Editor. Ten yr experience industrial, TV and promotional films. Thorough background covering research, preparing script with writer, budgeting, selecting crew for location and studio shooting, laboratory control, editing through final release print. Experienced with 35mm B & W, Eastman-color and 16mm color. Member of Editors Local NYC, IATSE. Married, wish to relocate out of New York City. Resume and references on request. Howard A. Mann, 284 Prospect St., East Orange, N.J.

Cameraman-Editor and Production Man wishes position with industrial, educational or commercial film producers. B.A. Univ. Miami in radio-TV-film productions. Worked as news cameraman and editor for local TV station. Presently employed as editor and assistant cameraman with producers of industrial films and TV commercials. Married, one child, willing to relocate. Read, write, speak Spanish. Resume available. Write: Sidney Platt, 300 S.W. 31 Ave., Miami 35, Fla.

Executive Management: To utilize professional experience of 24 years as Administrator-Consultant in all phases photo-industry: budgeting, planning, engineering, purchase & installation of equipment, training, operation maintenance, repair, with studios and processing labs. built and operated in the USA & abroad; heavy experience in sales, sales promotion and market surveys throughout the USA in various products. Write: Dana C. Rogers, 405 W. 23 St., Apt. 10A, New York 11; or phone WAtkins 4-8233.

Assistant Film Director. Experienced location work, scheduling, industrial and educational films, some editing, extensive theatre and writing background, desires production work New York area. Degrees in Journalism and Drama, age 29, veteran, single, excellent references. Resume on request. Write: S. M. Syna, 24 East 97 St., New York. Tel: TE 1-0444.

Writer-Director-Editor. Experienced in all phases film production, from dealing with sponsors to negative cutting. Have written and/or edited theatrical, television and industrial films. Considerable experience in sound recording and dubbing. Educational background includes work at Cornell, Columbia and USC Dept of Cinema. Desires permanent position with New York industrial film company. Resume on request. Write: E. S. Seeley, Jr., 91 Remsen St., Brooklyn 1, N.Y. Tel: ULster 2-1037.

Motion-Picture Engineer. Formerly Technical Supervisor, The Michael Todd Co., Inc. Expert all technical phases motion-picture production and exhibition. Specialized work with all wide-screen systems now in use. Professional background includes responsible positions in production and exhibition with: The Todd-AO Corp., NBC-TV, CBS-TV Newsfilm, 20th Century Fox, RCA Victor, Altec Service Corp. and others. Qualified engineering draftsman. College major: Radio-TV-Motion-Pictures. Age: 32; health: excellent. Seeking interesting, challenging position. Presently employed motion-picture recording. Willing to relocate. Carl E. Warner, 141-60 84th Rd., Jamaica 35, N.Y. Tel: Hickory 1-3357.

Positions Available

Design Engineer. Responsible for product design of new products in field of photog. and meteorological instrumentation based on specification and design parameters supplied. Must have: degree in mech. eng., knowledge of electrical and electronic principles desirable; 3 yr exp. product design or detailed board design in optical or photog. instrumentation and/or mech. or mech.-electrical instrumentation and/or precision devices for low to medium production volume; 1 yr prod. eng. or equiv. exp. in eng. liaison, prod. prototype planning or testing; considerable knowledge machine tools, sand and die casting techniques, material finishing processes, standard fasteners, bearings and other mech. hardware. U. S. citizen. Salary: $650-850 per month. Write: George Bingham, Beckman & Whitley, Inc., 973 San Carlos Ave., San Carlos, Calif.

Development Engineer. Responsible for creative engineering, development tests and experimental design of proposed products. Must have: degree in mech. eng. or eng. physics; thorough knowledge theoretical and applied eng. principles in mechanics, materials, optics, and some electronics; 2 yr exp. with optical devices and/or mech. or mech.-electrical instruments and/or cameras or photog. instrumentation; 3 yr exp. in development or research on precision mech. or elect. devices; high degree creative eng. ability, ability to perform detailed math. analysis of applied eng. problems and outstanding record of performance. U. S. citizen. Salary: $650-800 per month. Write: George Bingham, Beckman & Whitley, Inc., 973 San Carlos Ave., San Carlos, Calif.

Company Manager. Exceptional opportunity for qualified man with 18 year old Los Angeles manufacturer of film laboratory equipment. Must be over 30, preferably experienced in laboratory equipment manufacture and operation, capable of evaluating product design. Full management responsibility. Require a leader to direct operations, develop equipment, spark sales, keep things moving! Good salary with genuine growth opportunity. Write qualifications and experience: Clyde D. Graham, 672 South Lafayette Park Place, Los Angeles 5, Calif.

Executive Personnel. Expanding 16 & 35mm film company with modern equipment in new building seeks competent, qualified and conscientious executive to take responsibility for lab work, producer's services, sound, animation and direction of production. Permanent position with security. Experience in some or all phases of operation essential; applicant should be interested in more than a routine job; opportunity for profit sharing and possible ownership. In application, give age, education, experience and salary requirements. All replies in strictest confidence. Write: Lab, P.O. Box 411, Dallas, Texas.

Medical X-Ray Film Technical Sales. Unique opportunity with national distributor of medical X-ray film for man with at least 2 yr chemical engineering college and exceptional selling personality. Must have knowledge of medical X-ray film developing, testing and evaluation in order to demonstrate film. Zest, initiative and get-up-and-go are also a must. Starting as salesman in New York area, position as technical sales manager will be open to applicant proving his mettle. Good salary plus commission with genuine growth opportunity. Write qualifications and experience to: L. Monteleoni, 1105 Park Ave., New York 28.

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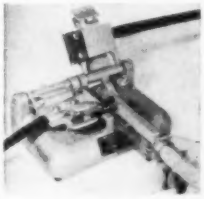


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Contents — pages 38 - 64

News Columns

Papers for the 83d Convention 38
1958 Directory for Members 38
Education, East Coast 38
Education, Industry News 40
BOOKS REVIEWED 41
Closed Circuit TV System Planning, by Morris A. Mayers and Rodney D. Chipp, reviewed by Boyce Nemec; *8MM Cine Manual,* by H. A. V. Bulleid, reviewed by Wm. H. Offenhauser, Jr.; *The Movies,* by Richard Griffith and Arthur Mayer, reviewed by Bernard D. Plakun; *The Liveliest Art,* by Arthur Knight; *Photojournalism,* by Arthur Rothstein; *Photo-Lab-Index,* Quarterly Supplement No. 74; "Ten good books of cinematographic knowledge," by Frederick Foster,, *Am. Cinemat.,* Dec. 1957; *Graphic Communication and the Crisis in Education,* by Neal E. Miller et al.
New Products 48
Journals Available 62
Employment Service 62

Advertisers

Berndt-Bach, Inc. 47
Byron, Inc. 64
Camera Equipment Co. 51
Camera Mart, Inc. 54
Canadian Applied Research, Ltd. 53
Filmline Corp. 46
Fish-Schurman Corp. 41
Florman & Babb 40
General Film Laboratories, Inc. 43
Harwald Co. 63
Hollywood Film Co. 45
Kling Photo Corp. 59
La Vezzi Machine Works 62
Magnasync Mfg. Co., Ltd. 55
Motion Picture Laboratories, Inc. 52
Movielab Color Corp. 49
PRA Products, Inc. 58
Peerless Film Processing Corp. 50
Precision Film Laboratories, Inc. 44
Prestoseal Mfg. Corp. 48
Professional Services. 60
SMPTE 39, 61
Stewart-Trans-Lux Corp. 56
Tri Art Color Corp. 57
Westrex Corp. 42

Meeting Calendar

American Mathematical Society, 64th Annual Meeting, Jan. 28–30, Cincinnati, Ohio.

American Physical Society, Jan. 29–Feb. 1, Stanford U., Stanford, Calif.

American Society for Testing Materials, National Committee Week, Feb. 10–14, Hotel Statler, St. Louis.

National Society of Professional Engineers, Spring Meeting, Feb. 13–15, Kellogg Center, East Lansing, Mich.

IRE, AIEE, U. of Penn., Symposium on Transistors, Feb. 20–21, U. of Penn., Philadelphia.

Electronic Industries Association (formerly RETMA), March Quarterly Meeting, Mar. 15–17, Sheraton Park Hotel, Washington, D. C.

IRE National Convention, Mar. 24–27, New York.

Inter-Society Color Council, 27th Annual Meeting, Mar. 25–26, Sheraton-Park Hotel, Washington, D. C.

Optical Society of America, Mar. 27–29, Sheraton-Park Hotel, Washington, D. C.

Microwave Research Institute, Polytechnic Institute of Brooklyn, Symposium on Electronic Waveguides, Apr. 8–10, Engineering Societies' Bldg., 33 West 39th St., New York.

IRE, AIEE, ASME, Conference on Automatic Techniques, Apr. 14–16, Statler Hotel, Detroit.

83rd Semiannual Convention of the SMPTE, including Equipment Exhibit, April 21–26, Ambassador Hotel, Los Angeles.

PGCP, AIEE, EIA, WCEMA, Electronic Components Symposium, Apr. 22–24, Ambassador Hotel, Los Angeles.

Electrochemical Society, Apr. 27–May 1, Statler Hotel, New York.

National Academy of Sciences, Annual Meeting, Apr. 28–30, Washington, D. C.

NARTB, 36th Annual Convention, Apr. 28–May 1, Biltmore & Statler Hotels, Los Angeles.

Professional Group on Microwave Theory and Techniques, National Symposium, May 5–7, Stanford U., Stanford, Calif.

Acoustical Society of America, Spring Meeting, May 7–9, Washington, D. C.

Society of American Military Engineers, 38th Annual Meeting, May 20–21, Washington, D. C.

Armed Forces Communications and Electronics Association, National Convention, June 4–6, Sheraton Park Hotel, Washington, D. C.

WESCON, Aug. 19–22, Ambassador Hotel, Los Angeles.

Fourth International Congress on High-Speed Photography, including Equipment Exhibit, Sept. 22–27, Cologne.

Society of Photographic Scientists and Engineers, Annual Technical Conference, Oct. 6–10, Manger Rochester Hotel, Rochester, N.Y.

Optical Society of America, Oct. 9–11, Hotel Statler, Detroit, Mich.

National Electronics Conference, Oct. 13–15, Hotel Sherman, Chicago.

84th Semiannual Convention of the SMPTE, Oct. 20–24, Sheraton-Cadillac, Detroit.

American Standards Association, Ninth National Conference on Standards, Nov. 18–20, Hotel Roosevelt, New York.

Acoustical Society of America, Nov. 21–23, Chicago, Ill.

85th Semiannual Convention of the SMPTE, including International Equipment Exhibit, May 4–8, 1959, Fontainebleau, Miami Beach.

86th Semiannual Convention of the SMPTE, including Equipment Exhibit, Oct. 5–9, 1959, Statler, New York.

87th Semiannual Convention of the SMPTE, May 1–7, 1960, Ambassador Hotel, Los Angeles.

88th Semiannual Convention of the SMPTE, Fall, 1960, Shoreham Hotel, Washington, D. C.

89th Semiannual Convention of the SMPTE, Spring, 1961, Royal York, Toronto.

90th Semiannual Convention of the SMPTE, Oct. 15–20, 1961, Statler, New York.

SMPTE Officers and Committees: The rosters of the Officers of the Society, its Sections, Subsections and Chapters, and of the Committee Chairmen and Members were published in the April 1957 Journal.

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